

# Assessment of Chemistry Teachers' Competence in Practical Chemistry in Secondary Schools in Makurdi, Benue State, Nigeria

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## ABSTRACT

This study was aimed at assessing the competence of chemistry teachers in the teaching of practical chemistry in secondary schools in Makurdi, Benue State, Nigeria. Areas of competence included teachers' knowledge, attitude and skill. Method of assessment of teachers' competence included use of a questionnaire (titled Teachers' Competence Questionnaire (TCQ)) for teachers' self-assessment ratings as well as students' and school authorities' ratings of the teachers. TCQ was validated and its reliability was 0.87 using Cronbach Coefficient Alpha. Survey research design was adopted for this study. Data were collected, collated and analyzed to answer three research questions. 360 students, 18 teachers and 12 principals from a sample of 12 schools participated in the study, out of the population of 110 government approved schools in Makurdi metropolis. Descriptive statistics of percentages was used to analyze the data. Findings indicated that the teachers' knowledge and skill were above average, but their affection was below average, in practical chemistry. Their overall competence was moderate. It was recommended that government and school proprietors should encourage and motivate chemistry teachers, through appropriate and prompt remunerations and provision of adequate laboratory materials, to improve their affection for practical chemistry.

**Keywords:** Assessment; teacher's competence; teaching; practical chemistry; secondary schools; Makurdi Nigeria

## 1. INTRODUCTION

One of the slogans of Fafunwa (1998) was 'no standard of education can rise above the quality of its teachers'. As in all areas of evaluation in education, the competence of a teacher is usually assessed in the cognitive, affective and psycho-motor domains. According to Pearson (2018), three judgments must be made to identify a person as a competent teacher. These are judgment of the effectiveness of the teacher in the areas of knowledge, attitude and skill. Boekaerts (1991) describes competence as learnt attitudes and aptitudes, manifested as

capabilities for controlling and mastering life problems by the use of cognitive and social skills.

Teachers' competency in teaching and learning is an important factor in determining the success of a teaching session. Their ability and wisdom in handling learning activities will have a direct impact on students' active involvement in learning activities. Therefore, the development of teachers' competency involving the efforts of fostering positive attitudes was a major factor to strengthen the teaching profession

and to ensure great development of the quality of education in many countries around the world (Awang, Jindal-Snape & Barber, 2013).

Chemistry can be defined as the study of the nature, composition, structure, preparations, properties and uses of the various forms of matter, and how substances behave or react under different conditions of energy and when in contact with one another. It investigates the principles governing the changes matter undergoes (Mailumo, Agogo and Kpagh; 2007). It is one of the physical sciences comprising of both theoretical and practical aspects. These make its teaching and learning to involve the use of all the science process skills (such as observation, experimentation, instrumentation, classification, theorizing and hypothesizing) and the adoption of all the pedagogical methodologies (such as demonstration, discussion, excursion and Socratic methods).

Moreover, the knowledge of chemistry has numerous applications both in the home and in the workplace. Research on chemical products such as soap, detergents, creams, plastics, dentifrices, fibers, pesticides, fertilizers and metallurgical utensils keep improving the quality of human life. It is one of the core science subjects students are required to credit in order to qualify for admission into tertiary institutions to study science and science-related courses such as medicine, pharmacy, engineering and technology.

Furthermore, the teaching and learning of chemistry in the Senior Secondary School (SSS) system facilitate the acquisition of the scientific process skills necessary for further studies in tertiary institutions. Hence, the present Nigerian educational system has a lot of challenges as there are persistent reports of poor performance of students in chemistry in external examinations such as the West African Examinations Council (WAEC) and the National Examinations Council (NECO) (Ogunleye, 1999).

The functions of chemistry-related associations such as the Chemical Society of Nigeria (CSN), Science Teachers Association of Nigeria (STAN) and Mathematical Association of Nigeria (MAN) make effort to address the issue of poor achievement of students in the subject. These associations organize seminars, conferences, symposia, workshops and other refresher courses with the objective of improving teaching and learning (Ndioho, 2014).

However, it is disheartening that in spite of all the efforts of Nigerian science educators, students' achievement in chemistry in external examinations has not yielded the desired results. External examination boards, like WAEC and NECO, in their annual reports, consistently indicate below average performance of its candidates. The achievement of Nigerian students in chemistry from 2001 to 2017 revealed a fluctuation of results of mostly less than 50 % mean score (i.e. pass at credit level and above) [*Source: WAEC and NECO Chief Examiners' Annual Reports on Chemistry*].

Chief Examiners' Reports of the external examinations bodies, such as WAEC and NECO, show a direct correlation between achievement of students in the chemistry practical and theoretical sections. Students who score highly in the practical papers also score highly in the theoretical papers, and vice versa. Moreover, students who are exposed to more practical work and experiments tend to comprehend the subject better and hence achieve more in the subject.

Examining the relative influence of some related factors that affect students' performance in practical chemistry, Okebukola (1987) worked with 819 students, 39 teachers and 39 schools in Oyo State, Nigeria. His findings indicated students' participation in laboratory activities was the most important factor when considering students' performance in practical chemistry. The other factors that followed were in this order: students'

attitude to chemistry as a subject; teachers' attitude to chemistry practical work and the availability of lab materials. This research assessed teachers' competence within the cognitive, affective and psychomotor domains of behavioural objectives in the teaching of practical chemistry. Cognitive domain describes the knowledge aspect, affective domain denotes the attitudinal aspect (including interest, motivation, incentives, diligence, obedience, honesty and punctuality) while the psychomotor domain has to do with the process skill aspect of practical chemistry.

Copriady (2014) randomly selected 234 chemistry teachers in Riau, Indonesia, to participate in his survey study of 'Teachers' Competency in the Teaching and Learning of Chemistry Practical' using a questionnaire, as the main instrument. His finding showed that chemistry teachers competency in designing a practical chemistry experiment was Beta = .686,  $t = 2617$ , sig = 0:00 <0.05, and  $R^2 = .470$ . This meant that chemistry teachers' competency in designing the lesson was moderate at 47%. Furthermore, he found that competency for practical implementation, as predictor, provided Beta = .700,  $t = 14\ 986$ , sig = 0:00 <0.05,  $R^2 = .490$ , which showed moderate competency contribution of 49%.

Atamonokhai, Yusuf and Ekeocha (1989) had a survey study on the role-expectations of practical chemistry teachers in selected secondary schools in Makurdi. Factors that were identified to be dampening the interest, zeal and enthusiasm of the teachers, in organizing practical lessons with students, then included inadequate motivation and incentives, due to poor remunerations and not paying workers' salaries promptly. Other factors were inadequate provisions of laboratory equipment, apparatus and reagents for routine practical sessions.

Makurdi, which is the headquarter of Benue State, Nigeria, has over 110 public and private post-primary schools. They include Secondary Schools, Special Science Secondary Schools and Technical Colleges,

all of which are offering science subjects, including Chemistry. The State government, through its Ministry of Education, Science and Technology and its Teaching Service Board, has set specific standards in determining the implementation of quality education in accordance with extant education laws covering education curriculum, competency of teachers, educational infrastructure, organization of learning activities and educational assessment. Everything is interconnected in ensuring the standard of quality. In this regard, particular attention is given to the quality of science teachers in order to create scientific-minded citizens for socio-economic development. This study assessed the competence of teachers in the teaching of practical chemistry, in the cognitive, affective and psychomotor domains of behavioural objective, in Makurdi, Benue State, Nigeria.

### ***1.1 Statement of the Problem***

Science subjects require practical training as well as theoretical studies. Therefore, to be competent, chemistry teachers need to be effective and efficient in designing, planning, implementing and evaluating the theoretical and practical lessons, using cognitive, affective and psycho-motor abilities and capabilities.

Students need to be nurtured to love science and to positively practice scientific culture. According to Kamisah, Zanaton and Lilia (2007), positive attitudes towards science and scientific activities would exist through constant conduct of experiments and continuous assessment of practical activities. Hence, this study assessed chemistry teachers' competence in carrying out practical chemistry experiments in the laboratory.

As it is with learners, a teachers' competence could be assessed in the three domains of behavioural objective, viz. cognitive, affective and psychomotor. Consequently, this study assessed secondary school chemistry teachers' competencies in teaching practical chemistry within the

cognitive, affective and psychomotor domains, in Makurdi metropolis of Benue State, Nigeria.

### **1.2 Purpose of the Study**

The purpose of this study is to assess chemistry teachers' competence in the teaching of Practical Chemistry in Secondary Schools in Makurdi, Benue State, Nigeria. Specifically, the study sought to assess:

- (1) Chemistry teachers' cognitive competence in the teaching of secondary school practical chemistry.
- (2) Chemistry teachers' affective competence in the teaching of secondary school practical chemistry.
- (3) Chemistry teachers' psycho-motor competence in the teaching of secondary school practical chemistry.

### **1.3 Research Questions**

- (1) What is the level of cognitive competence of chemistry teachers in the teaching of secondary school practical chemistry?
- (2) What is the level of affective competence of chemistry teachers in the teaching of secondary school practical chemistry?
- (3) What is the level of psycho-motor competence of chemistry teachers in the teaching of secondary school practical chemistry?

## **2. METHOD AND PROCEDURE**

This study is of survey design using questionnaires as instrument. One questionnaire, consisting of three sections with 10 items each, was used to obtain data for answering the three research questions that were asked to guide the study.

360 students, 18 teachers and 12 principals of a sample of 12 schools participated in the study, out of the entire population of 110 government approved schools in Makurdi metropolis comprising 5500 students, 220 chemistry teachers and 110 principals. The study was carried out in the 2017/2018 academic session.

A simple random sampling technique, by hat and draw method, was used. The name of each school was written on a small piece of paper, which was squeezed and put in a hat. 12, out of 110, were randomly picked for the study.

One questionnaire titled Chemistry Teachers' Competency Questionnaire (CTCQ) [comprising three sections as Affective Competence Questionnaire (ACQ), Cognitive Competence Questionnaire (CCQ) and Psycho-motor Competence Questionnaire (PCQ)] was administered on 12 principals, 18 teachers and 360 students of the sampled schools for the assessment of their teachers. Each section of the questionnaire consisted of 10 items, each of which was weighted as Excellent (5), Above average (4), Average (3), Below Average (2) and Poor (1). The means of the total assessment scores of the principals, teachers and students, of the participating schools, as well as their corresponding percentage frequencies were used in answering the research questions.

The questionnaire was validated, in terms of adequate coverage and clarity of items, by three lecturers one of which is an expert on measurement and evaluation from Benue State University (BSU), Makurdi, Nigeria. One of the remaining two lecturers, who validated the instrument, is a chemistry examiner with West African Examination Council (WAEC) and the other is a chemistry education lecturer of BSU, Makurdi. Furthermore, the reliability coefficient of the instrument was calculated to be 0.87, using Cronbach Coefficient Alpha.

## **3. RESULTS AND DISCUSSION**

The results of the study were organized according to the research questions asked to guide the study. Mean scores, of the questionnaire items, and their corresponding percentages were interpreted to arrive at ratings.

### **(1) Research Question 1**



What is the level of affective competence of teachers in the teaching of secondary school practical chemistry?

**Table 1: Affective Competency Rating**

Mean score of teachers in ACQ	Percentage frequency (%)	Rating
1.851	37.03	Below average

ACQ = Affective Competency Questionnaire

Table 1 reveals that the teachers scored 1.851, which is equivalent to 37.03 %, in their affection for laboratory work. This denotes that the teachers exhibited below average level of affective competence in the conduct of secondary school practical chemistry lessons.

### (2) Research Question 2

What is the level of cognitive competence of teachers in the teaching of secondary school practical chemistry?

**Table 2: Cognitive Competency Rating**

Mean score of teachers in CCQ	Percentage frequency (%)	Rating
3.187	63.74	Above average

CCQ = Cognitive Competency Questionnaire

Table 2 shows that the teachers scored 3.187 which is equivalent to 63.74 % in the knowledge of the content of practical chemistry. This indicates that the teachers exhibited above average level of cognitive competence in the conduct of secondary school practical chemistry lessons.

### (3) Research Question 3

What is the level of psycho-motor competence of teachers in the teaching of secondary school practical chemistry?

**Table 3: Psycho-motor Competency Rating**

Mean score of teachers in PCQ	Percentage frequency (%)	Rating
3.008	60.15	Above average

PCQ = Teachers' Psycho-motor Competency Questionnaire

Table 3 implies that the teachers scored 3.008, which is equivalent to 60.15 %, in their psycho-motor skills for laboratory work. This suggests that the teachers exhibited above average level of psycho-motor competence in the conduct of secondary school practical chemistry lessons.

**Table 4: Grand Mean of the Competences' Rating**

Grand mean score of the teachers	Percentage frequency (%)	Rating
2.682	53.64	Slightly above average

Table 4 shows the grand mean rating of the teachers' competences in the cognitive, affective and psycho-motor domains. Holistically, the teachers obtained overall mean score of 2.682 (53.64 %). This indicates an overall competence that was slightly above average.

## 4. DISCUSSION OF FINDINGS

This section describes major findings of the study. They are as follow:

The teachers' cognitive and psycho-motor competences were above average. Their respective mean scores were 3.187 and 3.008 out of a maximum score of 5 each, which represented 63.74% and 60.15%. This high level of competence might be due to the fact that most of the chemistry teachers of the sampled schools were university graduates. According to the National Policy on Education (2014), the least qualification for teaching in a Nigerian secondary school is the National Certificate of Education (NCE); and NCE holders in a Science Department can only teach Basic Science and Agricultural Science at the Upper Basic level (i.e. Junior Secondary School). Only graduates with at least a bachelor's degree in chemistry, or chemistry education, are allowed to teach the subject at the Senior Secondary School level.

However, the chemistry teachers' affective competence was below average. Their mean score of 1.851 out of a maximum 5 (representing 37.03%) indicates low attitudinal competence. The reason for this might be due to low morale of teachers in Makurdi metropolis as they were poorly paid and many of them were being owed salaries for months. Moreover, many of the schools lacked adequate infrastructural facilities, equipment, apparatus and reagents for the effective and frequent organization of practical sessions for students.

The low affection of teachers for practical chemistry might be responsible for the below average achievement of students in secondary school chemistry in Makurdi metropolis. According to Tiffany and Xuemei (2002) and Nwagwu in Ibitoye and Adeneye (2002), attitude towards a phenomenon affects its success.

However, the chemistry teachers obtained overall mean score of 2.682 (53.64 %). This indicated an overall competence that was slightly above average. This finding agreed with Copriady (2014) whose study on chemistry teachers' competency in the teaching and learning of chemistry practical in Indonesia was found to be moderate.

Consequently, it is recommended that the government and proprietors of schools should endeavour to pay teachers salaries promptly and increase their remuneration. Also, adequate infrastructural facilities, equipment, apparatus and reagents should be available for the effective and frequent teaching of practical chemistry. Hopefully, these measures would boost the morale, interest, enthusiasm, diligence and other affective traits of the chemistry teachers.

## 5. CONCLUSION

Based on the findings of this study, it can be concluded that the teachers had above average level of cognitive and psycho-motor competences. The study also revealed less than average level of affective competence of the teachers. However, on the whole, the teachers had amoderate competence rating.

Consequently, it was recommended that government and school proprietors should encourage and motivate chemistry teachers. These could be through appropriate and prompt remuneration and provision of adequate laboratory materials, to improve their affection towards secondary school practical chemistry.

Motivation and incentives of chemistry teachers for frequent and effective teaching of practical chemistry

would improve the achievement of students in practical chemistry. Generally, this would improve students' achievement in chemistry.

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## APPENDICES

### A. Chemistry Teachers' Competency Questionnaire (CTCQ)

Name of School:.....Date:.....

Control No.

Respondent's Name:,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,Gender:.....Status:.....

#### I. Affective Competence Questionnaire (ACQ)

Affective Trait	5	4	3	2	1
1. Punctuality of teacher and students to practical classes					
2. Regularity of teacher and students to practical lessons					
3. Promptness in marking students' practical workbooks					
4. Show of motivation, incentives and interest for practical work					
5. Ensuring students take precautionary and safety measures					
6. Adequacy of lab equipment, apparatus and reagents for students' practical					
7. Ensuring students keep lab neat and tidy during and after each session					
8. Enforcing rules and regulations of the use of the laboratory					
9. Assisting students to be honest and diligent in taking accurate measurements					
10. Eliciting students' interest and enthusiasm in practical work					

#### II. Cognitive Competence Questionnaire (CCQ)

Cognitive Behaviour	5	4	3	2	1
1. Clarity of explanation of concepts					
2. Adequate use of examples and illustrations in explaining concepts					
3. Effective use of mathematical and chemical formulae and equations					
4. Adequate use of question and answer method					
5. Adequate involvement of students in practical work during each lesson					
6. Attending to students based on their individual differences and difficulties					
7. Effective use of instructional materials including relevant diagrams.					
8. Effective elicitation of students' attention, responses and active participation					
9. Indication of mastery of the topic by depth of content and clarity of design					
10. Ensuring overall comprehension of the topic by all the students					

#### III. Psycho-motor Competence Questionnaire (PCQ)

Psycho-motor Skill	5	4	3	2	1
1. Audibility and fluency of speech					
2. Readability and clearness of handwriting					
3. Effective use of instructional materials, including ICT					
4. Effective use and manipulation of lab equipment and apparatus					
5. Effective demonstration of precautionary and safety measures					
6. Adequate mobility in the lab to attend to students; needs and challenges					
7. Ensuring honest and diligent generation of data through accurate measurement					
8. Ensuring students comply with appropriate conventional format of reporting					
9. Assisting students to be honest and diligent in taking accurate measurements					
10. Encouraging students' creativity, innovation, improvisation and team work					

**Key:** 5–Excellent, 4–Above average, 3–Average, 2–Below average and 1–Poor  
ICT = Information and Communication Technology.

### B. Calculations, Using Collected Data, to Arrive at Competence Ratings

I. Total number of respondents (comprising 360 students, 18 teachers and 12 secondary school principals) = 360 + 18 + 12 = 390

$$\text{II. Mean Rating of Affective Competence} = \frac{(5 \times 27 + 4 \times 30 + 3 \times 42 + 2 \times 50 + 1 \times 241) \times 10}{390 \times 10}$$

$$= \frac{135 + 120 + 126 + 100 + 241}{390} = \frac{722}{390} = 1.851$$

As a percentage, the mean rating =  $\frac{1.851}{5} \times 100\% = 37.03\%$

$$\text{III. Mean Rating of Cognitive Competence} = \frac{(5 \times 75 + 4 \times 80 + 3 \times 123 + 2 \times 67 + 1 \times 45) \times 10}{390 \times 10}$$

$$= \frac{375 + 320 + 369 + 134 + 45}{390} = \frac{1243}{390} = 3.187$$

As a percentage, the mean rating =  $\frac{3.187}{5} \times 100\% = 63.74\%$

$$\text{IV. Mean Rating of Psychomotor Competence} = \frac{(5 \times 65 + 4 \times 76 + 3 \times 112 + 2 \times 71 + 1 \times 66) \times 10}{390 \times 10}$$

$$= \frac{325 + 304 + 336 + 142 + 66}{390} = \frac{1173}{390} = 3.008$$

As a percentage, the mean rating =  $\frac{3.008}{5} \times 100\% = 60.15\%$

V. Overall level of teachers' competence rating:

$$\text{Grand mean rating} = \frac{1.851 + 3.187 + 3.008}{3} = \frac{8.046}{3} = 2.682$$

$$\text{Equivalent percentage} = \frac{63.74 + 37.03 + 60.15}{3} = \frac{160.92}{3} = 53.64\%$$

#### VI. Table of Summary of the Calculations

Objective domain	Mean score	Percentage Score	Remark
Affective	1.851	37.03 %	Below average
Cognitive	3.187	63.74 %	Above average
Psychomotor	3.008	60.15 %	Above average
Total	8.046	160.92	–
Grand mean	2.682	53.64 %	Slightly above average

How to cite this article: Adikwu O, EsmondAtamonokhai S, Fatoki JO. Assessment of chemistry teachers' competence in practical chemistry in secondary schools in Makurdi, Benue state, Nigeria. *International Journal of Research and Review*. 2018; 5(5):179-186.

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