



## Relational Study of Chemistry Teachers' Content Knowledge and their Teaching Effectiveness in Bayelsa State, Nigeria

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### ABSTRACT

*This study investigates chemistry teachers' content knowledge and their teaching effectiveness in Bayelsa state public secondary schools. The aim of the study was to find out the content knowledge demonstrated by the teachers during instruction in the classroom and the extent of teaching effectiveness of the chemistry teachers. Three research questions were asked and answered and one hypothesis was formulated and tested at 0.05 level of significance. The sample of the study comprised 25 chemistry teachers from 15 public secondary schools in Bayelsa State. Data for the study was collected through classroom observation, lesson noted checking and questionnaire. Descriptive and co relational statistics were employed in analysis of data. Finding showed that chemistry teachers in Bayelsa State demonstrated good content knowledge in some areas. The chemistry teachers' extent of teaching effectiveness is adequate. There is a significant relationship between chemistry teachers' content knowledge and their teaching effectiveness. The study concludes by recommending that principals should collaborate with government of Bayelsa State to sponsor chemistry teachers to workshops, seminars and conferences for updating of knowledge.*

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### INTRODUCTION

Teaching is one of the most important professions in the world. The teacher needs to possess vast knowledge in order to teach effectively for productive students' understanding and learning. The knowledge base of the teacher has been categorized as knowledge of content or subject matter, knowledge of classroom management, knowledge of pedagogy, knowledge of curriculum and curricular materials, Knowledge of students and their characteristics and misconceptions (Witterholt, Goedhart & Suhre, 2016; Verloop, Driel & Meyer, 2001). All over

the world, teachers are recognized as powerful instruments in the education industry. Their primary obligation is to guide students rightly in the pursuit of knowledge, skills and positive values and help them to develop healthy attitude for living in harmony with other members of the society. Teachers of good quality can influence rapid societal transformation. This is because teachers are critical agents of reform and change. Teachers can influence change and help to enhance the transformation of the society if they possess the relevant knowledge, skills, values and competencies. Teachers are



pillars in the educational system and any effort to reform the system centre on them (Eze & Njoku, 2011; Ibe, Adah, & Ihejamaizu, 2013).

Any chemistry teacher no matter the level of grooming he or she received from formal education and training, in the use of appropriate teaching strategies may not be competent in teaching the subject unless he/she has a thorough knowledge of the subject matter. Without adequate knowledge of content to be taught the teacher's efforts in imparting knowledge to students will be futile. Chemistry is one of the critical subjects in science education that deals with the study of the properties and compositions of substances and of the changes they undergo (Okecha, 1993). Chemistry is very important in scientific discoveries and inventions. There is hardly any endeavour in the sciences either pure or applied, where chemistry does not play some vital roles (Agogo & Otor, 2014).

Study conducted by Baumert, Kunter, Blum, Brunner, Voss, Jordan, Klusmann, Krauss, Neubrand and Tsai (2010) showed that an imperative positive relationship existed between a teacher's content knowledge and pedagogical content knowledge on instructional quality. Chemistry teachers need content knowledge in order to teach effectively to enhance students' academic performance in the subject at both internal and external examinations. The chemistry teachers must be equipped with all the necessary knowledge for them to be able to teach effectively and efficiently in order to be able to build a well-rounded child who can favourably compete in adventures of life (Dinama, 2013). He emphasized that mastery of the content knowledge is vital to the chemistry teacher because, it enables him/her to confidently and satisfactorily deliver the various concepts, as well as plan, implement and assess its delivery to students. Therefore, the chemistry

teachers' content knowledge is a critical factor in enhancing students' meaningful learning, understanding of concepts in the subject, active involvement and interest in learning and their academic performance. Chemistry teachers' content knowledge refers to the knowledge of the subject and the topic to be taught at any particular time or lesson. In this study, content knowledge is same as subject matter knowledge.

Teaching is a very complex activity, requiring several in-depth knowledge from the teacher. For students to learn meaningfully and productively, the teacher must be vast in content knowledge, knowledge of pedagogy and pedagogical content knowledge. The teacher's capability to teach effectively for students' productive learning and academic development is dependent on his/her content knowledge and pedagogical content knowledge. The quality of instruction is depended highly on the teacher's knowledge which has great influence on students' learning and academic progress. Even WAEC Chief Examiners Reports for several years highlighted the teachers' factors which has bearing with content knowledge an imperative factor responsible for students' poor performance in chemistry. Though studies are replete which focused on chemistry teachers characteristics as factors that affect his/her teaching effectiveness and students' learning outcomes, in Bayelsa state attention has not been concentrated on chemistry teachers content knowledge as imperative for his/her teaching effectiveness and students' learning. Hence this study is conducted to investigate chemistry teachers' content knowledge and their teaching effectiveness in public secondary schools in Bayelsa State.

### **Research Questions**

The study was guided by three questions as follows:



1. What content knowledge do secondary school chemistry teachers in Bayelsa State demonstrate during lesson in the classroom?
2. What is the extent of teaching effectiveness of chemistry teachers in Bayelsa and Delta States public secondary schools?
3. What is the relationship between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa State secondary schools?

#### **Hypothesis**

The hypothesis formulated to be tested at 0.05 level of significance is:

1. There is no significant relationship between content knowledge and teaching effectiveness of chemistry teachers in public secondary schools in Bayelsa State.

#### **LITERATURE REVIEW**

##### ***Content Knowledge and Teaching Effectiveness***

According to Shulman (1986), contents knowledge is a type of knowledge covering specific concepts related to the teaching topic, operations, evidences and proof and problem-solving capabilities and skills. It is the knowledge of concepts, theory for ideas, organizational frameworks, evidence and proofs in addition to established practices and approaches towards developing such knowledge (Shulman, 1987). This knowledge contains the knowledge that is learnt or taught (Mishra & Koehler, 2006). Teachers teaching certain subjects must have sufficient understanding of all the knowledge in their subjects.

Subject matter content knowledge has been described by several teacher education scholars to mean the kind of knowledge needed by the teachers for teaching (Shulman, 1986; Ma, 1999; Halim & Meerah, 2002; Vistro-Yu, 2003; Jong,

2003; Jong, Van Driel & Verloop, 2005; Rollnick, Bennett, Rhemtula & Dharsey, 2008). Content knowledge is the concepts, principles, processes, relationships and applications a student should know within and inside a given discipline or subject, appropriate for his/her organization of knowledge (Ozden, 2008). Guerriero (n.d) found that teachers' or instructors bring about higher better content knowledge of teachers in higher students' academic achievement. Teacher's content knowledge has an effect on both the content and the process of instruction, thus influencing both what and how they teach (Treagust, 2002). Ball and Bass (2000) carried out a study on the interweaving of content and teaching in mathematics. teaching and learning, their findings show that the subject matter knowledge needed by teachers is seen not only in the list of topics of the subject matter to be learned, but in the practice of teaching itself. This implies that knowing the curriculum content of any subject is not sufficient to justify the capability of a teacher being able to teach it. Rather, what makes a teacher capable of teaching is also how well the teacher is skilled to facilitate the learning. Hence, subject matter content knowledge can be created or developed through continuous teacher classroom practices.

Content knowledge is the knowledge one has for a specific discipline or topic (Parrotte, 2016). For example in chemistry, content knowledge in organic chemistry is the knowledge a chemistry teacher has for teaching international union of pure and applied chemistry terminology of organic compounds. Content knowledge represents the teachers' knowledge of the available programmes and curricular choices as well as all of the materials available for instruction. Of all the features of pedagogical content knowledge, content knowledge is the most easily assessed (Parrotte, 2016).



Ball, Thames and Phelp (2008) identified two categories of content knowledge as common content knowledge and specialized content knowledge. They noted that the common content knowledge is unswervingly related to what is being imparted or taught. For example, the common content knowledge for teaching balancing chemical equation would be different from the common content knowledge for teaching isomerism in chemistry. The specialized content knowledge is the knowledge the teacher would need to teach balancing chemical equation or isomerism. Leinhardt & Smith (1985) examined the expert teachers' subject matter knowledge in mathematics, using difficult topic-Fractions. They investigated subject matter content knowledge of fractions using interview and card-sorting tasks, as well as lesson observation. Their findings indicate that expert teachers were similar in their knowledge of subject matter but they differ in their classroom presentations. They argued that the difference necessitates in-service support that is tied to lesson presentation rather than independent thematic issues. Teachers having good knowledge of the teaching subject are very important for quality education (Akkoc, Ozmantar & Bingolbali, 2008; Kahan, Cooper & Bethea, 2004). Content knowledge is the knowledge of the discipline and its organizing arrangement and structure (Grossman, Wilson & Shulman, 1989; Ball, Thames & Phelps, 2008).

Content knowledge is a significant and fundamental essential for pedagogical content knowledge of the teacher (Ball et al, 2008). Halim & Meerah (2002) established that content knowledge had positive influence on pedagogical content knowledge. Teachers not having adequate content knowledge may hinder students' learning the subject very well (Aksu, Metin

& Konyalioglu, 2014). Content knowledge is a technical knowledge key to the foundation of teaching as a calling and a profession (Aksu, et al, 2014). In Mathematics, Leinhardt & Smith (1985) examined the content knowledge of expert teachers in mathematics, using difficult topic-Fractions. They used methods such as interview, card-sorting tasks and lesson observation in their investigation. Their findings indicate that expert teachers were similar in their knowledge of subject matter but they differ in their classroom presentations. Their findings also showed that teachers' mathematics knowledge influences their understanding of the lesson structure as well as the selection of examples, the formulation of explanations and demonstrations.

In addition, Isiksal and Cakiroglu (2011) explored pre-service teachers' knowledge of basic students' misconceptions with respect to the multiplication of fractions, sources of these misguided judgments and instructional strategies to defeat or overcome them. Data collection for the study was from seventeen Turkish mathematics prospective teachers. An instrument titled multiplication of fractions questionnaire was utilized in data collection in addition to semi-structured interviews. Their findings indicated that the prospective mathematics teachers experienced identified many misconceptions or difficulties that students have and the sources of the misconceptions or difficulties was from students' inadequate knowledge and rote memorization and remembrance of the logarithms.

They suggested three strategies for surmounting these misconceptions or difficulties as strategies based on instructional methods, strategies or approaches based on formal or standard knowledge of fractions and strategies/methodologies based on



psychological concepts/constructs. Ogbonnaya (2011) researched the relationship between teachers' subject matter knowledge and their teaching efficacy in mathematics lessons. He used document analysis such as journal and certification to gather data to assess teachers' content and pedagogical knowledge in mathematics. His finding indicated that teachers' subject matter knowledge had positive correlation with teachers' teaching effectiveness.

In general, Ozden (2008) carried out a study on the influence of content knowledge on pedagogical contents knowledge of science teachers. The sample of the study involved 28 student science teachers. Data for the study was collected through lesson plan, content knowledge test and semi-structured interview. The findings of the study discovered that the science student teachers had basic knowledge, few misconceptions and certain inadequacies at the conceptual level. The science student teachers' had difficulties about relationships between concepts influenced by their past experiences. The findings also demonstrated that most of the science student teachers had consistent content knowledge which influenced their effective teaching practices. Hence the author concluded that content knowledge influences positively pedagogical content knowledge and effective teaching of the science student teachers.

From all indications, content knowledge is a basic factor or element of pedagogical content knowledge. Possessing sufficient content knowledge is imperative for effective teaching and students' meaningful learning. Lack of adequate content knowledge by teachers may lead to misleading students by giving them incorrect knowledge which could jeopardize their future interest in the subject. Teachers' content knowledge is therefore a very significant factor in enhancing

competent teaching and learning.

## METHODOLOGY

This survey research adopted the co-relational design. The population consists of public secondary schools in Bayelsa State. Bayelsa state has 176 public secondary schools and 97 chemistry teachers as at May 2019. The sample of the study was drawn from four out of eight local government areas of the three senatorial districts of Bayelsa State. The sample comprised 25 chemistry teachers selected from senior secondary schools in Ekeremor, Ogbia, Sagbama and Yelnegoa, 15 principals and 80 students. The 80 chemistry students were all in SSS3 class. The sample (chemistry teachers) was selected using stratified sampling technique. They were grouped into five strata and the selection was based on the number of chemistry teachers in each stratum in the fifteen senior secondary schools. The 80 students were selected using simple random sampling technique.

Classroom observation, lesson note checking and questionnaire were the instruments for data collection. Through classroom observation and lesson note checking, the researcher was able to assess the content knowledge demonstrated by chemistry teachers during instruction. The questionnaire was administered to principals and senior secondary school 3 students to ascertain the chemistry teachers teaching effectiveness. The instrument was validated by two professors of science education in the Department of Science Education Delta State University, Abraka. The reliability of the instrument was determined using Chronbach Alpha technique. Reliability index of 0.90 was obtained and this justified the internal consistency of the instrument for use for this study. The instrument was subdivided into two parts. The first part contains nine items on content knowledge demonstrated



by chemistry teachers during instruction in the classroom. It was used as a classroom guide by the researcher in assessing the teachers' content knowledge. It was titled "Chemistry Teachers Content Knowledge Classroom Observation Guide" (CTCKCOG) the second part contains fourteen items which focused on chemistry teachers teaching effectiveness. It was titled "Chemistry Teachers Teaching Effectiveness Rating Scale" (CTTERS). It was structured on

a four point rating scale of strongly agreed (4), agreed (3), disagreed (2) and strongly disagree (1). The mid-point of the rating scale which served as bench mark for decision making as to accepting the item as positive or not accepting the item as negative was 2.50. Therefore, any item with mean score from 2.50 and above was accepted as positive (+) but an item having mean score from 2.49 and below was not accepted and therefore negative (-).

## RESULTS

**Table 1:** Mean Score analysis of the content knowledge demonstrated by secondary school chemistry teachers in Bayelsa State during lesson in the classroom

S/N	Items on Content Knowledge in Chemistry	Mean	SD	Remark
1	Planning lesson in line with the topic to be taught or taught for each lesson	2.70	0.52	+
2	Knowledge of chemistry generally	2.09	0.56	-
3	Knowledge of simple laws underlying each topic in chemistry	3.25	0.34	+
4	Knowledge of the content for each topic to be taught	3.30	0.46	+
5	Application of chemistry principles underlying specific topic to be taught	2.18	0.56	-
6	Knowledge of chemical theories	2.86	0.79	+
7	Knowledge of chemistry concepts for specific topic	2.82	0.65	+
8	Knowledge of entry behaviour for each chemistry topic	2.47	0.99	-
9	Knowledge of instructional materials to be used when teaching specific topic in chemistry	2.66	0.67	+

Table 1 is used to answer research question 1. It contains the result of data analysis based on content knowledge demonstrated by chemistry teachers Bayelsa State secondary schools during lesson in the classroom. The mean score of 2.50 was used as the mid-point and cut off point for arriving at decision. Items having mean score from 2.50 and above were accepted while items having mean score from 2.49 and below were not accepted. Items 1, 3, 4, 6, 7 and 9 have mean scores that exceeded the cut-off point 2.50. Therefore, these items represent the

areas where chemistry teachers in Bayelsa state secondary schools exhibited good content knowledge in the classroom during lesson. The chemistry teachers did not demonstrate good content knowledge in general knowledge of the subject, knowledge of chemistry principles underlying each topic taught and knowledge of entry behaviour.

**Research Question 2:** What is the extent of teaching effectiveness of chemistry teachers in Bayelsa and Delta States public secondary schools?



**Table 2:** Mean ratings of chemistry teachers teaching effectiveness in Bayelsa State public secondary schools

S/N	Items on Teaching Effectiveness in Chemistry	Mean	SD	Remark
1	Careful planning of each lesson period	3.21	0.60	+
2	Ability to communicate effectively with students during lesson	3.50	0.71	+
3	Regular attendance at class	2.83	0.73	+
4	Listening to students' opinions	3.12	0.95	+
5	Provision of relevant feedback to students	3.19	0.70	+
6	Use of relevant instructional materials for topics taught	2.17	0.86	-
7	Gets students actively engaged during instruction	2.26	0.69	-
8	Gives assignment that is relevant to topics taught	3.30	0.80	+
9	Exhibits care and respect for students	3.23	0.77	+
10	Clearly makes the objectives of lesson known to students	3.19	0.79	+
11	Ability to apply variety of instructional strategies during lesson	2.28	0.78	-
12	Ability to cover the curricula content outlined for each topic	3.18	0.85	+
13	Demonstrates enthusiasm for subject matter	3.28	0.80	+
14	Ability to differentiate learning for individual students	2.21	0.99	-

Table 2 is used to answer research question 2. It contains the result of data analysis based on rating of teaching effectiveness of chemistry teachers in Bayelsa State public secondary schools. The mean score of items 1, 2, 3, 4, 5, 8, 9, 10, 12, and 13 exceeded 2.50 which was used as the mid-point and cut off point for arriving at decision. Therefore these items represent areas where chemistry teachers in Bayelsa secondary schools are effective in

teaching while items 6, 7, 11 and 14 having mean score below 2.50 were not accepted, representing areas where the chemistry teachers are not effective in teaching the subject.

**Research Question 3:** What is the relationship between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa State secondary schools?

**Table 3:** Summary of Descriptive statistics and correlation between content knowledge and teaching effectiveness of chemistry teachers in Bayelsa State secondary schools

State	Variables	N	Mean	Std Dev	R	r <sup>2</sup>	Decision
Bayelsa	Content Knowledge	25	2.86	0.48	0.38	0.14	Medium Positive Relationship
	Teaching Effectiveness	25	3.25	0.42			

Table 3 shows the relationship between content knowledge and teaching

effectiveness of chemistry teachers in Bayelsa State secondary schools. Cohen



(1988) suggested that for determining the strength of relationship,  $r = .10$  to  $.29$  is small but  $r = .30$  to  $.49$  is medium. But  $r = .50$  to  $1.0$  = large. Therefore for Bayelsa State, since calculated  $r = .38$ , it means medium relationship between chemistry teachers content knowledge and teaching effectiveness.

**Hypothesis 1.** There is no significant relationship between content knowledge and teaching effectiveness of chemistry teachers in public secondary schools in Bayelsa State.

**Table 4:** Analysis of the relationship between content knowledge and teaching effectiveness of chemistry teachers in public secondary schools in Bayelsa State

State	Variables	N	Mean	Std Dev	r	P-Value	Decision
Bayelsa	Content Knowledge	25	3.113	0.552	0.46	0.000	Significant
	Teaching	25	3.254	0.521			
	Effectiveness						

From Table 4 the  $r$  value is 0.46 at 0.05 significant level. The  $r$  value of 0.46 is significant at 0.05 level. This means that there is a significant relationship between content knowledge and teaching effectiveness among chemistry teachers in Bayelsa State.

#### DISCUSSION OF FINDING

With respect to the first research question, the finding revealed that chemistry teachers in Bayelsa state public secondary schools demonstrated good knowledge in the classroom during instruction. The chemistry teachers exhibited good knowledge of the content of each topic taught, knowledge of simple laws underlying each topic taught, knowledge of chemical theories, knowledge of chemistry concepts for specific topics, they planned their lessons in line with the topic being taught, and knowledge of instructional materials to be used for each topic taught. This finding lends credence with Aksu, Metin and Konyalioglu (2014) they found that teachers having adequate knowledge of content facilitated their teaching and students' understanding of the topics taught. And that teachers not having adequate content knowledge may

hinder students' learning the subject very well. The finding further showed that there is a gap in the content knowledge of chemistry teachers in three areas such as general knowledge of the subject, knowledge of chemistry principles underlying each specific topic taught and knowledge of entry behaviour. Similar finding was reported by Baker and Robinson (2018) who found a gap in content knowledge of two teachers investigated. This lack of content knowledge by chemistry teachers in specific areas have the potentials of causing students' misconceptions and misunderstanding of topics taught. In addition the finding agreed with that of Brijlall (2014) who found that teachers lacked general knowledge of probability in mathematics class.

For research question 2, the finding showed that chemistry teachers in Bayelsa secondary schools are effective in teaching the subject in several areas as lesson planning, regular class attendance, effective communication during lesson, listening to students opinion, provision of relevant feedback to students, showing care and respect to students, giving relevant assignments, making the objectives of lesson known to student and covering of





curricula contents. The hypothesis testing indicates that a significant relationship exists between chemistry teacher's content knowledge and their teaching effectiveness. These findings concords with Ogbonnaya (2011) who found that teachers' subject matter knowledge had positive correlation with teachers' teaching effectiveness. Furthermore, the finding is in line with Akkoc, Ozmantar and Bingolbali, (2008) and Kahan, Cooper and Bethea, (2004). must have good knowledge of content or subject matter knowledge to teach any subject effectively. Moreso the finding is in line with Baumert, Kunter, Blum, et al, (2010) they found that positive relationship existed between a teacher's content knowledge and pedagogical content knowledge on instructional quality.

#### CONCLUSION

From the findings the study concludes that chemistry teachers of public secondary schools in Bayelsa state demonstrate good content knowledge in some areas during the teaching of chemistry in the classroom. The extent of teaching effectiveness of public secondary school chemistry teachers in Bayelsa state is adequate but needs some improvement in areas such as general knowledge of the subject, knowledge of chemistry principles underlying each specific topic taught and knowledge of entry behaviour. The chemistry teachers do not get students actively involved during lesson, they are not able to apply a variety of instructional strategies during lesson and do not differentiate learning for individual students. There is a significant relationship between chemistry teachers' content knowledge and their teaching effectiveness.

#### RECOMMENDATIONS

Based on the findings and conclusion reached, the study recommends that

1. Principals of public secondary schools in Bayelsa State should continue to support chemistry teachers so that they can sustain their teaching effectiveness.
2. Principals should collaborate with government of Bayelsa State to plan for upgrading of chemistry teachers content knowledge through organizing conferences, seminars and workshops for the teachers.
3. Public secondary school principals in Bayelsa state should empower chemistry teachers through within school workshops for continued improvement in their teaching effectiveness.

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