

THE INTERNATIONAL JOURNAL OF HUMANITIES & SOCIAL STUDIES

Biology Teacher's Pedagogical and Content Knowledge in Ondo State Secondary Schools: An Empirical Review

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Abstract:

Most educational scholars and teacher educators acknowledge the fact that subject matter and pedagogical knowledge are crucial to good teaching. Pedagogical and content knowledge are some of the important educational constructs that any effective teacher should adequately possess to improve students' academic performance because it guides the teachers' activities when dealing with subject matter in the classroom. Students' performance in both internal and external examinations is dependent on teachers' quality which in turn is determined by teachers' possession of pedagogical and content knowledge. In spite of the importance of teacher's quality and characteristics, performance at senior secondary school level has been below average. This empirical study therefore assessed the level of Biology teacher's pedagogical and content knowledge in Ondo State. 171 Biology teachers were observed during the teaching and learning process and a checklist/rating scale consisting of 23 items on teachers' pedagogical and content knowledge observable traits that are expected to be exhibited by the teachers during teaching and learning process. Also 5 multi-choice questions in Biology were given to the students in order to further assess the level of Biology teachers' content knowledge. Findings revealed that 52.1% of Biology teachers had a good level of pedagogical knowledge while 49.1% had a good level of content knowledge. The study concluded that teachers in Ondo State Secondary Schools exhibited a good level of pedagogical and content knowledge in teaching Biology.

Keywords: Biology, pedagogical knowledge, content knowledge, secondary schools

1. Introduction

Biology as one of the science subjects offered in senior secondary schools deals with the scientific study of living things, their relationship with one another and with the natural environment among other things. It is a core subject in Nigerian secondary school curriculum which is introduced to students at the senior secondary school level as a preparatory ground for human development, where career abilities are groomed, potentials and talents discovered and energized.

Education at secondary school level according to Ashikhia (2010) is supposed to be the bedrock and the foundation towards higher knowledge in tertiary institutions. Secondary schools not only occupy a strategic place in the educational system in Nigeria, it is also the nexus for primary and the university levels of education. In spite of the importance and acceptance of Biology among Nigerian students, performance at senior secondary school level has been fluctuating and sometimes below average. These performances stem from various factors which include poor school management, but more prevalently low teachers' quality, poor teachers' preparation and inappropriate use of pedagogical skills. Also mentioned were ineffective use of instructional materials, lack of classroom management as well as poor understanding of content concepts by teachers, etc. (WAEC, 2014).

From the above, one can infer that teacher's pedagogical and content knowledge is adequately and effectively needed to improve students' academic performance. Nuangchalerm (2012) sees pedagogical and content knowledge as the ability of teachers to understand a specific discipline along with teaching of that discipline. However, recent reports proved otherwise as there have been inconsistency in candidates' performance in Senior Secondary Certificate Examinations (SSCE) (WAEC, 2007). It is on this premise that the pedagogical and content knowledge of teachers will be assessed as one of the important form of teachers' professional knowledge in Ondo State Secondary Schools.

Ramalingam, (2005) defined Biology as the branch of science that involves the study of living things. Biology is a natural science concerned with the study of life and living organisms, including their structure, function, growth, origin, evolution, distribution, and taxonomy. Biology is a vast subject containing many subdivisions, topics, and disciplines. In all the definitions of Biology, one thing is prevalent: that Biology belongs to science family. It studies the nature of living things and the relationships between their forms. Biology if properly thought, will not only serve as a pre-requisite and school requirement for further science and applied science study but also a means of helping an individual to understand

himself well, develop a good use and functioning of all his senses, solve personal and societal problems. It is central to many science-related courses such as Medicine, Pharmacy, Nursing, Agriculture, Biochemistry, Microbiology etc. It is obvious that no student intending to study these disciplines can do without Biology. These factors among others have drawn attention of researchers and curriculum planners towards Biology as a subject in the school curriculum (Kareem, 2003). Learning Biology as well as other sciences, is therefore becoming more essential not only for the well-being of the individual, but also for the entire society.

Acknowledging the fact that Biology occupies a unique position in the school curriculum, the National Policy on Education (NPE, 2004) posits that "maintaining a viable educational system requires various elements, considerations and, of course, various resources". These are inputs that could lead to excellent output. Therefore, in any system of education, the following must be given adequate consideration: educational objectives; instructional materials including textbooks; funds; educative school environment (adequate infrastructural facilities, equipment, etc.); teacher's preparation, competence, utilization and advocacy. Teachers, being one of the important resources in implementing curriculum, the implementation of Biology curriculum have been a matter of serious concern to Biology educators. This concern arises from the fact that Biology occupies a central position in the scientific and technological development of any Nation (Maduabum, 1998) and Biology teacher also occupies a strategic position as the quality of teachers in any educational system determines to a large extent the quality of the system itself (NPE, 2004).

Research evidence by Nwuchukwu & Nwosu, (2007), and Dangbin, (2008) showed that most schools in Nigeria lack qualified science teachers, despite the fact that Biology teachers are major players in the successful implementation of Biology programme. As a result, students cannot achieve high levels of performance in the absence of skilled, talented and dedicated professional teachers. Accomplished science teachers are those who engage students in higher cognitive skills, who promote information literacy, and nurture collaborative classroom practices among students or indirectly influence the student's attitudes toward science which in consequence can influence students' achievement. The Biology curriculum, like any other science, is activity-oriented and student-centered. For this reason the following teaching methods were recommended, field studies, guided, discovery and laboratory techniques/skills. The teaching and learning of Biology like any other science subject demands active students' participation involving the use of material resources.

Recent trends in students' achievement records in both internal and external examinations show that the objectives of secondary school education in general and in particular in secondary school Biology in particular are not achieved. This implies that achievements have been below average. Reasons for the performance of Biology students in Nigeria have been attributed among other things to low teachers' quality, poor teachers' preparation and inappropriate use of pedagogical skills, poor understanding of content concepts by teachers, etc.

However, the issue of poor academic achievement of students has been of more concern to all and sundry. Oluremi, (2013) pointed that good buildings, good environment and equipment, special services and others can provide favorable learning but the learning experiences must be directed by competent teachers. The success of any teaching and learning process, which influences students' academic performance, depends on how effective and efficient the teachers are, and the quality of a teacher has a positive correlation with student achievement in school. Nwuchukwu and Nwosu (2007) found that science teachers are poorly trained in content and pedagogy.

Leach and Moon (2000) explain pedagogy as the practice that a teacher, together with a particular group of learners creates, enacts and experiences. In doing so they suggest that pedagogy is a joint activity in which the learner has an active role. Pedagogy is genuinely viewed as skillfully managing and enhancing the relationship between teaching and learning, whereby teaching procedures and strategies are selected for particular reasons that are important to shaping learning in ways that are meaningful and valuable to the learner. Pedagogical knowledge as defined by Shulman (1987) is an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learning, and presented for instruction. In the same vein, he defines content knowledge as the knowledge teachers have of the subject matter they are teaching. Content knowledge is defined as the knowledge of the subject matter of a school subject as contained in its curriculum. In other words, content knowledge refers to the various components of a subject which are put together to achieve the objectives for the teaching and learning of the subject.

Mishra and Koehler, (2006) characterized pedagogical and content knowledge as the manner in which subject matter are transformed for teaching. This occurs when the teacher interprets the subject matter and finds different ways to represent it and makes it accessible to learners. Many studies have examined elements of pedagogical and content knowledge and their relation to students' outcomes. To McCray and Chen, (2012) pedagogical and content knowledge is a prime construct of interest that relates positively with students outcomes. Kanter and Konstantopoulos, (2010) were able to capture the pedagogical and content knowledge construct more fully and found positive relationships between science teachers' pedagogical and content knowledge and students' outcomes.

Ashikhia, (2010) pointed that teachers also complained of students' low performance at both internal and external examinations. Studies have also shown that poor classroom organization, lack of management techniques, lack of teaching skills, ineffective delivery of content and poorly co-ordination of student activities were responsible for the poor performance of students and also reduced the quality of science teaching and learning (Folaranmi, 2002). Hence, to improve students' academic performance, there is the need for the teachers to be sound and knowledgeable both in content and pedagogy.

2. Objectives of the Study

The specific objectives of the study are to:

- Assess the level of Biology teachers' pedagogical knowledge in secondary schools in Ondo State.
- Assess the level of Biology teachers' content knowledge in secondary schools in Ondo State.

3. Research Question

The research seeks to provide answers to the following questions:

- What is the level of Biology teachers' pedagogical knowledge in Ondo State secondary schools?
- What is the level of Biology teachers' content knowledge in Ondo State secondary schools?

4. Theoretical Framework

This study was rooted in the work of Magnusson, Krajcik, and Borko (1999). The authors constructed a Pedagogical Content Knowledge Component Model for Science Teaching from an integrative view from the Pedagogical Content Knowledge construct of Shulman (1987). This Model made an accurate description of four pedagogical content knowledge components:

(1) knowledge about science curriculum, (2) knowledge about students' understanding of specific science topic, (3) knowledge about assessment in science, and (4) knowledge about instructional strategies for teaching science.

- Knowledge about science curriculum: this deals with teachers' knowledge about the goals and objectives of the science curriculum that they teach in the class along with the delivery of these goals and objectives throughout the topics taught and also the general knowledge about the science curriculum and certain materials and programs that are related to the topic being taught in order to accomplish these goals.
- Knowledge about students' understanding of specific science topic: This component involves knowledge about the requirements for learning and knowledge about areas of student difficulty. Teachers of science (Biology) are expected to be observant about the required abilities and skills for the students to be able to learn the certain science topics and students' varying abilities and react favorably in order to be effective. In the same vein, Biology teachers should value the students' prior knowledge about the topic and build upon the students' prior knowledge.
- Knowledge about assessment in science: Knowledge about the science learning that is important to be assessed in a specific unit and knowledge about the assessment methods. According to Earl (2003), for appropriate assessment of students' learning, teachers need to use their personal knowledge of the students and their understanding of the curriculum in the context of the assessment. The research findings of Tacoshi and Fernandez (2014) reveals the lack of knowledge in the assessment field and strongly suggests the necessity to invest in continuous professional development programs, especially with respect to assessment practices. Biology teachers should know the necessary assessment tools that are to be used in assessing students' understanding. Tests can be given to assess the students' understanding of the topic.
- Knowledge about instructional strategies for teaching science: Not only do science teachers need subject matter knowledge for specific topics that are covered in science classroom, but also they need to know about effective teaching and learning strategies to transmit this knowledge to students. In order to transmit knowledge to students, Biology teachers need to know students' naive ideas about scientific phenomena.

Good teaching is not only about knowledge but also the capability to reason soundly about teaching. Sound reasoning by teachers requires both a process of thinking about their actions and a sufficient collection of content, principles and experience from which to reason (Shulman, 1987). The research findings of Magnusson *et al.* (1999) reveals that teachers with differentiated and integrated knowledge have greater ability than those whose knowledge is limited and fragmented. Therefore, the significance of their study offers an insight into the importance of science teachers' pedagogical and content knowledge in Biology education in order to enhance effective and efficient during teaching and learning process.

5. Methodology

The population for this study consisted of all secondary school Biology teachers in secondary schools in Ondo State. A sample of 171 Biology teachers was selected from public and private secondary schools in the state using multi-stage sampling technique. From each of the three senatorial districts, three Local Government Areas (LGAs) were selected using simple random sampling technique. Ten secondary schools were selected from each LGA also using simple random sampling technique. Two Biology teachers were then selected from each school using simple random sampling technique.

Two research instruments were used to collect data for the study. These are Biology Teachers' Classroom Observation Checklist/Rating Scale (BTCOCRS) and Biology Teachers' Content Knowledge Rating Scale (BTCKRS). The BTCOCRS consists of 23 items on teachers' pedagogical and content knowledge observable traits that are expected to be exhibited by the teachers during teaching and learning process. The BTCKRS consists of 5 multi-choice questions in Biology which was adapted from Beals, Krall and Wymer (2012) and was administered to the students to further assess Biology teacher's content knowledge. Data collected were analysed using frequency and percentage.

6. Results

The raised questions were answered using a four point Likert scale that was scored 4=Excellent, 3=Good, 2=Fair and 1= Poor. The procedure used in the assessment of the level of teachers' pedagogical and content knowledge was by

observation using Biology Teachers' Classroom Observation Checklist/Rating Scale. This was also supported by the use of Biology Teachers' Content Knowledge Rating Scale to further assess the level of content knowledge of the teachers. The total score for each respondent was calculated and then analysed.

Teachers' Knowledge	Teachers' Score
Poor Knowledge	0%-39%
Fair Knowledge	40% -49%
Good Knowledge	50%- 69%
Excellent Knowledge	70% -100%

Table 1: Distribution of Biology Teachers' Pedagogical and Content Knowledge

As could be observed in Table 1, Biology teachers were categorized by their knowledge in Biology. Those in the group of 0-39% were classified as having poor knowledge, those in 40-49% grouped as fair, those scoring 50-69% were grouped as good, whereas those falling in the group 70-100% were classified as having excellent knowledge. Professional etiquette requires that teachers handling a particular subject should possess more than fair knowledge of the subject so as to impart appreciable knowledge of the subject matter to the students (Eggen&Kauchak, 2001).

Level of Teachers' Knowledge	Frequency	Percentage (%)
Poor Knowledge	11	6.4
Fair Knowledge	11	6.4
Good Knowledge	89	52.1
Excellent Knowledge	60	35.1
Total	171	100

Table 2: Assessment of the Level of Biology Teachers' Pedagogical Knowledge in the Study Area (Mean Score =38.3)

Assessing the level of pedagogical knowledge of the respondents, it was revealed that 11(6.4%) of the teachers had a poor level of pedagogical knowledge and 11(6.4%) had a fair level of pedagogical knowledge. It was also revealed that 89(52.1%) of the teachers had a good level of pedagogical knowledge and 60(35.1%) of the teachers had an excellent level of pedagogical knowledge. This implies that there existed a good level of pedagogical knowledge among teachers in the study area. This was further buttressed by a mean score of 38.3 which further emphasized that there existed a good level of Biology pedagogical knowledge among Biology teachers in Ondo state.

Level of Teachers' Knowledge	Frequency	Percentage (%)
Poor Knowledge	0.0	0.0
Fair Knowledge	57	33.3
Good Knowledge	84	49.1
Excellent Knowledge	30	17.5
Total	171	100

Table 3: Assessment of the Level of Teachers' Content Knowledge in the Study Area (Mean Score =29.5)

Table 3 reveals that 0(0.0%) of the teachers had poor level of content knowledge while 57(33.3%) of the teachers had a fair level of content knowledge and 84(49.1%) had a good level of content knowledge. It was also seen that 30(17.5%) of the teachers had an excellent level of content Knowledge. This implies that the teachers in the study area had a good level of content knowledge in teaching Biology in the study area. Also, a mean score of 29.5 showed that the teachers in the study area had a good level of content knowledge in the study area.

Based on the results obtained from the analyses presented in Tables 2-3, the research questions revealed that there was a good level of pedagogical and content knowledge among the Biology teachers studied. With the use of the classroom observation checklist, it was observed that teachers were fair in adequate preparation, relevance and effective use of instructional resources, good method of presentation (teaching methods) and distribution of time. It was also observed that the teachers under observation displayed a high level of knowledge in explaining the concepts and contents but were average in relating the concepts taught to real life situations and were also average in the use of examples and the flow or arrangement of the components on the whole topic.

7. Conclusion

The study concluded that teachers in Ondo State Secondary Schools exhibited a good level of pedagogical and content knowledge in teaching Biology. In order to achieve an excellent landmark in student's academic performance in the State, the following recommendations were put forward:

- Ministry of education and inspectorate division should encourage teachers of Biology to regularly attend seminars, workshops and conferences to up-date their pedagogical and content knowledge.
- Biology teachers should increase their knowledge of various pedagogies and endeavour to learn subject matter thoroughly in order to keep students engaged and motivated throughout the teaching and learning process through STAN programmes.
- Curriculum planners should develop the curriculum to an extent that teachers are enabled to better shape students' cognitive, psychomotor and affective domains of students in Biology.
- Biology teachers should create an atmosphere conducive for learning in order to enhance the development of students' learning experiences.

8. Implication of the Study

The study has basically focused on the level of Biology teacher's pedagogical and content knowledge in Ondo State Secondary Schools.

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