



## IMPROVING SECONDARY SCHOOL BIOLOGY TEACHERS' PEDAGOGIC CONTENT KNOWLEDGE (PCK) WITHIN A CONSTRUCTIVIST FRAMEWORK

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### ABSTRACT

*In spite of the preponderance of in-service education programmes in Nigeria, no noticeable impact has been recorded in terms of actual improvement in the quality of secondary school biology teaching. The purpose of this study therefore was to ascertain the effect of a Constructivist-based in-service model on secondary school biology teachers' pedagogic content knowledge (PCK). The study which employed the posttest-only control group experimental design investigated seven dimensions of the teachers' pedagogic content knowledge. The subjects comprised 80 biology teachers in Imo state. The mean, standard deviation and t-test were employed to analyse the data. The result revealed that the Constructivist-based in-service model was effective in improving the secondary school biology teachers' PCK in all the seven dimensions.*

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**Keywords:** Pedagogic content knowledge (PCK), Constructivist epistemological framework, Conceptual change, In-service programme, Science-technology-society (STS), Learning cycle, Biology teachers, Capacity building, Teacher education.

### 1. INTRODUCTION

The need to strengthen biology teaching at the secondary school level appears to be well recognized (Ajewole, 1997; Nwosu and Nzewi, 1997; Ndioho, 2007). Efforts toward the actualisation of this need have essentially focused on four discernable approaches: (a). improvement of the curriculum, (b). designing of various instructional methods and strategies (c) instructional resources and (d) improvement of the quality of the secondary school biology teacher. It would appear there is a consensus among experts in the field of teacher education that focusing on the improvement of the quality of the teacher has a superlative advantage (Shulman, 1986). This is so because the best curriculum and the best instructional method can fail at the hand of an ill prepared teacher. On the contrary, a well groomed teacher is sure to find his bearing even when the other conditions are not as good as they should be. Accordingly, current theories of teacher

education tend to emphasize the development of the pre- and in-service knowledge base of the teacher. This knowledge base has been described in terms of the subject content knowledge and the pedagogic content knowledge (PCK) (Shulman, 1986) (Van Driel *et al.*, 1998). Interestingly enough, studies in this field have consistently revealed no relationship between subject matter knowledge and pedagogic content knowledge (Parker and Heywood, 2000). This therefore implies that irrespective of a secondary school biology teacher's subject content knowledge, he still needs to develop his pedagogic content knowledge in order to function effectively.

Pedagogic content knowledge (PCK) is defined as a "teacher's interpretations and transformation of subject knowledge in the context of facilitating students learning" (Van Driel *et al.*, 1998). Although there is a considerable disparity among experts on the exact meaning of PCK, there appears to be a convergence of opinion on the following characteristics of PCK:

- It differs considerably from subject matter knowledge per se.
- It is developed through an integrative process rooted in classroom practice, which implies that pre-service or beginning teachers possess little or no PCK (Van Driel *et al.*, 1998).

Dart *et al.* (1998), stressed the importance of focusing on the development of teachers PCK within the constructivist epistemological framework. Yet as Dykstra (1992) observed, "effective development and utilization of pedagogy requires a better and more detailed understanding of conceptual change. In other words, for 'teachers to teach constructively, they too must learn constructively'" (Nworgu, 1999; Yager, 2000).

The problem with existing in-service programmes for secondary school biology teachers is that they do not rely on an appropriate epistemological framework, and/or they have remained largely traditional in their design and execution. This raises the question: Will a Constructivist-based in-service education model enhance biology teachers' pedagogical content knowledge (PCK)?

### 1.1. Purpose

The purpose of this investigation was to determine the relative efficacy of STS-Constructivist-based in-service education model in terms of secondary school biology teachers' pedagogical content knowledge (PCK)?

### 1.2. Hypothesis

It was therefore hypothesized that: biology teachers exposed to a constructivist-based in-service model and their counterparts who were not so exposed will not differ significantly in terms of their pedagogic content knowledge (PCK).

## 2. METHODOLOGY

### 2.1. Design

The investigation adopted a posttest-only control group design. The design is shown below:

Experimental Group:	R	X	O
Control Group:	R	-	O

## 2.2. Subjects

The subjects for the study were 80 biology teachers from 40 senior secondary school from the three (3) Senatorial Zones of Imo State. Ten senior secondary schools were selected from each senatorial zone.

Initially, 20 senior secondary schools were randomly selected and two (2) biology teachers from each of the schools were selected to undergo a short-term in-service programme based on the STS-Constructivist model. This constituted the experimental group. For each school in the experimental group, another senior secondary school of comparable status was selected as a control. Two biology teachers were randomly selected in each school making a total of 80 teachers (40 Experimental and 40 Control).

## 2.3. The STS-Constructivist In-Service Model

The Model was designed based on the STS-Constructivist framework to suit a short-term in-service (or capacity building) programme for biology teachers. Essentially it comprised:

- (1). Grouping of teachers into 'Learning Circles'. Each 'Learning Circle' comprised teachers from four contiguous or nearby schools (i.e. 8 biology teachers) and democratically electing its leader.
- (2). A 30- minute Circle Leaders Forum where the leaders and programme facilitators shared information and arrived at a consensus on the modality of executing the capacity building programme including the roles of the leaders and the members during and after the programme
- (3). A 5-day intensive capacity building programme for all the teachers comprising short interactive presentations by facilitators that were followed by Learning Circle Activities. The presentations took into cognizance the prior ideas of the biology teachers. The content of the short in-service programme included:
  - overview of the Senior Secondary Biology Curriculum - structure, philosophy, objectives, content, suggested teaching and evaluation methods
  - Basic Concept and Principles of STS-Constructivist Pedagogy
  - Developing lesson plans based on the Indigenous Communicative Lesson Plan Model (UNICEF, 2003).
  - Appropriate Teaching Methods and Strategies
  - Resources for biology teaching
  - STS-Constructivist Assessment techniques
- (4). Short plenary presentations by each Learning Circle
- (5). Monitoring and supervision of classroom implementation of the skills and materials developed during the programme. This was carried out by both the Learning Circle Leaders and the Facilitators.

## 2.4. Instrumentation

A-5 point Likert-type scale was used to elicit data teaches on the first two PCK dimensions- "Confidence to teach Biology and Understanding of the nature of Biology. The scale was validated

by a staff panel from the University of Nigeria and had a coefficient of temporal stability (established through test-retest method with one week interval) of 0.86.

Data relating to the PCK dimensions 3 to7 were collected from the analysis of video tapes of the lead teachers' lessons. In reviewing and analyzing the lessons, the following indices were used:

1. Number of questions [for PCK dimension3];
2. Time (in minutes) [for PCK dimensions 4,6,and 7]
3. Number of questions and time (in minutes) [for PCK dimension 5].

Three (3) different raters who are specialists in Biology Education were used to analyse the tapes and lessons. Using Kendall's Coefficient of Concordance (W), an inter-rater reliability estimate of 0.89 was obtained for the ratings of the three experts on PCK categories 3-7.

### 2.5. Data Analysis

Means and standard deviations were employed to describe the data. The t-test for independent samples was used to test the hypotheses.

### 3. RESULTS

**Table- 1.** T-test of the Significance of the Difference between Experimental and Control Groups on PCK Dimensions 1 and 2.

PCK Dimension	Constructivist (n=40)		Control (n=40)		Standard Error	t-cal. <sup>+</sup>
	Mean	S.D	Mean	S.D		
1. Confidence to teach	38.26	5.34	31.94	5.78	1.55	4.08*
2. Understanding the nature of the biology as a science discipline	34.29	6.02	27.71	4.98	1.53	4.30*

+ Critical value of t at 5% level of significance and 78 df for 2-tailed test = ]

\*Significant, p<0.05.

The result of the analysis revealed that the program made a statistically significant (p<0.05) impact on the teachers PCK with respect to confidence to teach science and understanding of the nature of biology as a science discipline respectively.

Table- T-test of the Significance of the Difference between Experimental and Control Groups on PCK Dimensions 3-7.

PCK Dimension	STS-Constructivist (n=40)		Control (n=40)		Standard Error	t-cal
	Mean	S.D	Mean	S.D*		
3. Asking questions	18.27	3.13	12.02	2.44	0.39	16.03*
4. Dispensing information	9.78	3.37	19.73	5.70	1.10	-9.05*
5. Using students questions in terms of:						
a)						

Continue

b) Number		12.06	4.89	7.32	2.67*	0.78	6.08*
c) Time (minutes)		26.73	5.89	12.60	3.43*	1.16	12.18*
6. Spending time at the front of the class		9.64	3.43	20.75	6.15*	1.33	-8.35*
7. Interaction with students		35.49	7.93	16.38	4.06	1.98	10.16*

Based on the t-test analysis, the difference between the Constructivist group of biology teachers and the control group was significant ( $P < 0.05$ ) on PCK dimensions 3 -7. In other words, the STS-Constructivist teachers demonstrated improved or better PCK in all the five dimensions of PCK

#### 4. DISCUSSION

As revealed in this study, the Constructivist-based in-service model was efficacious in developing biology teachers PCK. To the extent that teaching effectiveness is determined by a teacher's PCK (Shulman, 1986; Parker and Heywood, 2000), teachers who have improved PCK would generally be more effective in impacting their students' learning. This implies that by exposing biology teachers to this model, students learning in biology will be enhanced. This fact is buttressed by the results of studies on the effect of in-service programme models predicated on the constructivist framework on students' learning. These studies (Yager *et al.*, 1992; Kellerman, 1993; McComas, 1993; Kellerman and Lui, 1996);(Blunck, 1993; McComas, 1996) have adduced overwhelming evidence regarding what teachers who participated in a Constructivist-based in-service programme – the Iowa-Chautauqua in-service program, accomplished in terms of their students' learning.

#### 5. CONCLUSION

The Constructivist-based in-service model has been found to be effective in improving those dimensions of secondary school biology teachers' PCK that relate to:

1. Confidence to teach
2. Understanding to the nature of
3. Asking questions
4. Dispensing less information
5. Using student' questions to drive discussion
6. Spending less time at the front of the class
7. Spending more time interaction with individual students

The model should therefore be employed in the continuing professional development of serving secondary school biology teachers as this would empower them as constructivist teachers.

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