Content-Specific and Pedagogical Knowledge: An Approach for Enhanced Science Education for Self-Reliance in Nigeria

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Abstract
The paper discussed the concepts of content specific and pedagogically knowledgeable science educator in the delivery of science curricular in Nigeria. It examined the notion of discipline-specific knowledge (DPK) which is delineated into two distinct traditional lines of research and was broken down into several dimensions and components of knowledge base required for science teaching. In addition, some pedagogical approaches and their basic assumptions were highlighted as a correlate for effective delivery of science curricular. It was concluded that, we need science educators that have content specific and pedagogical knowledge for Nigeria to become a giant nation and enhance the attainment of self reliance of its citizens in all spheres of national development.

Introduction

Today, teaching as a profession is almost taken over by all manner of people who have not acquired sufficient content knowledge for classroom instruction. These people now see teaching as a past-time-job or a stop-gap to an anticipated more lucrative and promising job. For this group of individuals whom many cannot be said to be proficient end up with teaching as a last resort. The question to be asked is who is an ideal science educator? However, the answer you will receive also depend on the individuals' discipline-specific (content) pedagogical knowledge (DPK). Science education field is generic dealing with pedagogical knowledge need for presenting ideas and materials for teaching and learning science. Thus, science education encompasses a wide area of specialization which translates to the usage of different methods for knowledge presentation in the classroom. It therefore means that, developing teaching skills alone is not sufficient to become an effective teacher in science education. One must also develop the understanding and requirement of his own discipline. This is termed discipline-specific pedagogical knowledge (Lenze, 1995; & Bethiaume, 2007).

Another way through which science educators can gain pedagogical knowledge is through accredited academic practice programmes (AAPP) for new teachers or through continuing professional development (CPD) in one's disciplinary area. In such scenario, the science teacher becomes a disciplinary specialist who knows how to teach and foster learning in his field.

Discipline-Specific Pedagogical Knowledge (DPK) Model

Researchers have indicated that, students are the most qualified to report on which teaching method is productive, informative, satisfying or worthwhile. While students opinion may not be legitimate indicator of students satisfaction with teaching method evidences on the use of such ratings for evaluating teachers exist in over 2000 articles and books written in the past 70years (Sajjad 2012). Sajjad (2012) opined that institutions around the world adopt anonymous feedback rating systems at the end of each course completed to rate teachers. Evaluation of teachers assists in further development and improvement on their teaching skills and administrators for personnel decisions (Ovy, 2000). To this end, in the field of educational research, the notion of DPK has been examined from two distinct traditional lines of research (Heather, Steve & Marshall, 2009). They include:

1. Research on the knowledge base for teaching.
2. Research on disciplinary specifics in University teaching.

Within the context of research on knowledge base for teaching; three distinct components have been found to play a crucial role. These are:

1. The teachers' knowledge about teaching (i.e. the relative consensual, cognitive understanding that informs skill and teaching and the body of dynamics)
2. Beliefs relating to teaching which are mostly personal, untested assumptions, premises or suppositions that guides teaching actions and
3. Goals' relating to teaching which the teacher tries to accomplish as expectations and intentions about instruction which may be short or long term.

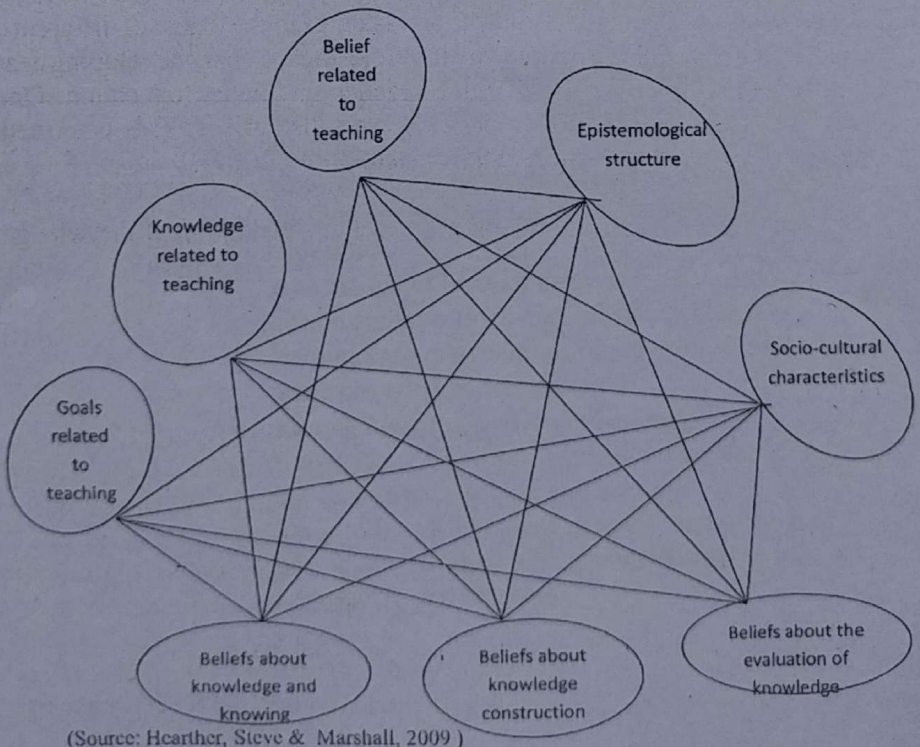
And again within research on disciplinary specificity; two types of characteristic have been found to influence what one does when teaching a given discipline. These characters include:

1. Socio-cultural characteristics of the discipline which are socially constructed through the establishment of morals, practices or rules within a group of individuals
2. Epistemological structure of the discipline which determines how the field is structured.

Yet each of these lines of educational research is limited in its ability to represent the notion of DPK in its full complexity. However, linking the two lines together enable us to examine the phenomenon of DPK and knowledge base teaching with elements of discipline specificity which provides a way to consider internal and external factors contributing to the formation of DPK.

The empirical model of DPK is presented in Figure 1. The model has included elements from a third source, namely the teachers' personal epistemology which are his belief about knowledge and its development (Baxter-Magolda, 2002). The model of DPK presented incorporated the three lines of research identified. Therefore, the DPK teacher develops complex relationships between the various components coming from these sources.

Figure 1: Model of Discipline-Specific Pedagogical Knowledge (DPK) for Teaching.



(Source: Hearther, Steve & Marshall, 2009)

Table 1
Dimensions Associated with Components of the Knowledge Base for Teaching

Components	Emerging Dimensions and Description
1. **Goals related to teaching.** (Expectations and intentions of the teacher that may be long or short time)	• **Course level goals :** What the teacher wants to achieve during the course? • **Class level goals :** What the tea cher wants to achieve after a given class. • **Ordering of goals:** The precedence of goals for a particular course class programme. • **Accomplishment of goals:** The attainment of the teachers goals in the course class levels • **Future goals :** Goals arising after the course or class.
2. **Knowledge needed for Teaching.** (Body of dynamic and relatively consensual cognitive knowledge and Skills of teaching)	• **Knowledge of content:** Knowledge of the discipline • **Pedagogical Knowledge:** Content knowledge of teaching specific aspects of the content. • **Knowledge of self :** Certain aspect of the teachers' personality that impact on teaching • **Knowledge of learning and learner:** Knowledge of learner's characteristic s and actions. • **Knowledge of assessment of learning:** Knowledge of princ iples or method s of assessment. • **Knowledge of curricular issues:** Knowledge of relationship between topics or course taught by colleagues. • **Knowledge of human behavior: Knowledge** of how human reactions may affect teaching and learning (group dynamics, Interp ersonal relations and non-verbal communication). • **Knowledge of physical environment:** Knowledge of how ph ysical arrangement or location affect teaching and learning. • **Knowledge of logistical issue:** Knowledge of how administr ative bureaucracy affects/ impac t on teaching and learning.

3. **Socio-Cultural Characteristics:** (Establishment of norms and Practices that regulate individuals)	• **Teaching in the discipline:** Norm's, conventions or rules that prevails among colleagues that teach same or similar discipline. • **Learning in the discipline:** Norm's, conventions or rules that seem to prevail among students' that learn same discipline. • **Practicing in the discipline:** Norm's, conventions or rules that guides practicing among colleagues or students' in the disciple.
4. **Epistemological structure;** (Nature and organization of Knowledge in the field)	• **Description of the discipline:** The nature of the teacher's discipline about the level of complexity or difficulty • **Organization of the discipline:** How the branches/ sub – branches of the discipline evolves over time. • **Relation to other disc ipline:** How the disciplin e relates or compares to other disciplines.
5. **Beliefs related to teaching** (Views of what constitutes Knowledge and actions associated with being able to know).	• **Belief about the purpose of teaching:** The teacher's expectations directed at graduates • **Belief about the conditions for instruction:** Teacher's view on basic requirements for effective teaching in the University. • **Belief about teaching and t eachers:** Teachers' views about role and responsibilities of teachers'. • **Belief about learning and learners : -** Teachers' views about the role and responsibilities of learners.
6. **Beliefs about knowledge Construction;** (Development and accumulation of Knowledge)	• **Beliefs about how students learn**: Learning and knowledge construction applicable to individuals. • **Beliefs about how students learn specifically:** Learning and knowledge construction that is specific to their discipline.
7. **Beliefs about knowledge Evaluation.** (Attributes of value)	• **Beliefs about the relative value of knowledge:** Teacher's belief on the ordering of certain sources of knowledge. • **Belief about how to evaluate knowledge Teachers: -** Belief on relative importance of knowledge

(Source: Hearther, Steve & Marshall, 2009)

Pedagogical Approaches for Enhanced Science Education for Self Reliance in Nigeria

There are many teaching methods the science educator has at his disposal for effective knowledge presentation. The choice of a method will depend on certain critical issues; the extent of freedom for curriculum presentation; employer involvement in course specification and delivery; recruitment imperatives such as the numbers of subjects and lessons to be taught by the teacher; widening access, participation, aspirations and differentiated learning environments. However, Table 2 below expresses these pedagogical approaches and their basic assumptions.

Table 2
Pedagogical Approaches and their Basic Assumptions

Pedagogy	Basic Assumptions
1. **Lecture Method**: it is essentially a teacher directed approach that is mostly talk or verbal presentation.	A. Teacher must be experienced and a have proper mastering of subject matter. B. Materials to be learnt must be stimulating and thought provoking. C. Information's should be supported with memorable and rational examples. D. Points must be explained clearly without ambiguity. E. Lecturers must provide separate notes at the end of the class lesson.
2. **Discussion Method**: is used in discussing problems or topics that students already have prio-knowledge on to determine differences in their opinion. But this approach is difficult and challenging in teaching science.	A. Quality time is needed to prepare the objectives for discussion B. The teacher is the moderator and facilitator of the discussion. C. The classroom environment must be conducive for effective discussion. D. Students' must listen to other participants Views for adequate evaluation. E. Sufficient time should be allotted for discussion and conclusion drawn.
3. **Problem Based Learning Method**: Technical Colleges rely on this method of teaching. The problem gives direction to learning how to solve the problem which is similar to the apprenticeship system of education.	A. The Problem must be identified. B. Develop deeper understanding of nature of the problem. C. Identify the cognitive skill applicable. D. Develop skills for critical analysis of phases (stages) of the problem. E. Encourage independent learning, collaborative (group work) and communication skills.
4. **Use of ICT:** use of virtual learning environment as a means of dissemination, interaction and learning support system. Power points, simulations, animations, drills and practice are some of its features.	A. A lot of time is needed in designing. B. Organizational skill is highly demanded. C. Ensuring that materials are interactive. D. Should follow inductive learning principle (i.e. from simple to complex). E. Teacher is always available for Clarifications when necessary.

The pedagogical approaches highlighted shows of the basic assumptions that will guide the science educator in selecting the appropriate methodology to be used or adopted by the teacher in planning, preparation and teaching the content of science curricular. So, to be a discipline specific teacher is to be appropriately armed with various pedagogical knowledge of teaching in order to effectively deplore the approach that would be most suitable for teaching. What teachers' should have at their minds is that, there is no single most appropriate method of teaching science, however the combination of two or more of these approaches at the same time or different periods may aid the science educator in his task of teaching. It is equally important that teaching should bring about behavioural changes or modifications in cognitive knowledge, skills and attitude exhibited by the students. When these domains are not visible or exhibited by students then the teacher needs to reexamine his methodology or adopt a new approach to get the desired result from instruction.

Conclusion

One of the goals of Science Education programme is aimed at producing innovative science teachers that have capacities for effective teaching of science contents. The concept of discipline (content) specific teacher and pedagogical knowledge discussed in this paper can help bring desirable changes in the ways teachers' transmit knowledge in the classroom. And if Nigeria hopes to become technological giant nation in Africa and compete favourable in global world, then the foundation lies in sound and effective science education programme anchored on deployment of pragmatic and innovative teaching methods that would translate to better teaching and learning in our classrooms for self reliance.

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