Assessment of Secondary School Science Teachers Pedagogical and Content Knowledge (TPACK) in Minna Niger State

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Abstract

An assessment of the levels of pedagogical knowledge (PK), content knowledge (CK) and pedagogical content knowledge (PCK) of science teachers in Minna Niger state. The research design is descriptive statistics. The researcher's developed a five-point Likert scale questionnaire which had fifteen constructs each on PK, CK and PCK. All science teachers in Minna form the population. The sample size for the study were two hundred science teachers. The data collected were analyzed using the mean and standard deviation. An average mean of 3.0 was used as the benchmark; teachers who scored below the average mean had low PK, CK and PCK, and teachers who scored above the average mean had high PK, CK and PCK. The results showed that grand means of 3.54 was gotten for PK, 3.50 for CK and 2.50 for PCK indicating that teachers had high PK and CK while the level of their PCK was low. It was recommended that teachers should be given capacity training on pedagogical content knowledge (PCK), among others.

Keywords; *Teachers' Pedagogical and content knowledge, Content Knowledge, Pedagogical Knowledge, and Science teachers.*

Introduction

Teaching any subject is a highly complex cognitive activity in which the teacher must apply knowledge from multiple domains. Teachers with differentiated and integrated knowledge may have a greater ability than those whose knowledge is limited and fragmented. Teaching is a process of delivering knowledge between teachers and students. This process involves planning, implementation, evaluation, and feedbacks (Shahabuddin et al) in Jacob 2020. It requires thorough planning in order to produce effective teaching which will consequently lead to effective learning in the classroom. In any profession, there is a specialized professional knowledge that makes it unique and distinct with striking features entirely different from other professions. One of the characteristics of good teachers is that they possess a substantial amount of specialized knowledge for teachers known as Teachers' pedagogical content knowledge.

TPACK is a structure which aims to define the knowledge that teachers need while they are integrating it in their teaching. With the use of it they deal with the sophisticated and fixed nature of teacher knowledge Koyuncuoglu (2021). Lee Shulman (1986) who proposed the concept of PCK, describes it as teachers' understanding of "the most useful forms of representation of the most powerful analogies, illustrations, examples, explanations, and demonstrations. In a word, the ways of representing and formulating the subject that makes it comprehensible to others. Teachers of a specific subject should possess special understandings and abilities that integrate their knowledge of the subject's content and student learning of this content. This special knowledge, called Pedagogical Content Knowledge (PCK), distinguishes the science knowledge of teachers from that of scientists. Pedagogical content knowledge, defined by Shulman as the special amalgam of content and pedagogy that is uniquely the providence of teachers and their own special

form of professional understanding. Another important idea is that teaching science based on the methods advocated by current reforms is fundamentally different from how most teachers learned science themselves yet research indicates that teachers unfortunately, tend to teach the way they have been taught. The above arguments suggest that preparation of science teachers should be a purposeful intellectual endeavor that needs to be carried out by professionals who possess strong expertise in the content area and can apply it to learning of science and simultaneously have skills and experience in implementing the reformed way of teaching in a classroom.

Pedagogy can be defined as the art of teaching. • Pedagogical knowledge involves being able to convey knowledge and skills in ways that students can understand, remember and apply. • Pedagogical skills can generally be divided into classroom management skills and content-related skills. Pedagogical content knowledge plays an important role in the teaching and learning process because it involves teacher's competences in delivering the conceptual approach, relational understanding and adaptive reasoning of the subject matter (Kathirveloo *et al.,* 2014). Content knowledge is the "knowledge about actual subject matter that is to be learned or taught" (Mishra & Koehler, 2006). Teachers must know about the content they are going to teach and how the nature of knowledge is different for various content areas. Our own content knowledge affects how we interpret the content goals we are expected to reach with our students. It affects the way we hear and respond to our students and their questions. It affects our ability to explain clearly and to ask good questions.

Pedagogical content knowledge is special amalgam of content and pedagogy that is uniquely the province of teachers and their own special form of professional understanding. Key elements in shulmans' conception for PCK are knowledge of representations of the specific content and instructional strategies on the one hand and understanding of learning difficulties and students' conceptions of specific content on the other. Content knowledge is defined as the concepts, principles, relationships, processes, and applications a student should know within a given subject matter. It includes knowledge of concepts, theories, ideas, knowledge of proofs and evidences as well as practices and approaches to develop this knowledge. Pedagogy is knowledge of teaching, instruction and training. It includes the educational purposes, the methods of teaching and learning, knowledge about techniques or methods used in the classroom, the nature of the target audience, and strategies for assessing students' knowledge.

Amidst growing concerns in the education industry regarding the quality of teachers and how it affects the process of teaching and learning. The success or failure in the process of teaching a particular concept lies in the pedagogical approach adopted by the teacher, without which the teaching would appear to the students as abstract. For a teacher to function effectively he/she has to have good skills in communication, collaboration, proper knowledge of classroom management, proper knowledge of subject matter and effective teaching methods (Jacob *et al* 2020). However, there have been a major problem of low PCK among science teachers and how it translates into increasingly sophisticated methods for engaging diverse students in mastering challenging subject content and basic skills, lack of science teachers mastery of content, lack of inept knowledge of the lessons presented to students, science teachers not being able to carry out learning objectives, teachers inability to apply adequate teaching methods to attract students interest, inability of teachers to differentiate cognitive and learning intelligence among students so as to enable them prepare contents that that are not too high for the students to learn in one lesson, inability of

teachers to prepare a proper daily lesson plan in a correct context according to syllabus and to carry out the curriculum in a given time there by leading to students' understanding difficulties in science especially in the aspect of Science. In view of the afore mentioned challenges faced by teachers in teaching and learning, this study aims at assessing Secondary School Teachers Pedagogical and Content Knowledge in Minna, Niger state. This will help in the quest to identify teachers with low PCK and derive possible ways in which they can be improved which will in turn improve the quality of teaching in the state.

Aim and Objectives

The aim of this current study is to Assess Secondary School Science Teachers' pedagogical and content knowledge in Minna Niger State. This aim would be fulfilled through the following specific objectives to:

4. Identify science teachers' level of Pedagogical Knowledge (PK),
5. Determine science teachers' level of Content Knowledge (CK),
6. Examine science teachers' level of Pedagogical and Content Knowledge (PCK).

Research Questions

5. What is the level of science teachers' Pedagogical Knowledge (PK)?
6. What is the level of science teachers' level of Content Knowledge (CK)?
7. What is the level of science teachers' Pedagogical and Content Knowledge (PCK)?

Methodology

This research was conducted by using a descriptive survey research design. The population of the study comprises of all science teachers in the selected public senior secondary schools in Minna, Niger State. The sample size is two (200) hundred science teachers randomly selected from 10 public secondary schools. A researcher developed instrument which consists of five-point Likert-type questionnaire on pedagogical knowledge (PK), content knowledge (CK) and pedagogical and content knowledge (PCK). The questionnaire was validated by two science education experts from Federal University of Technology and College of Education Minna, Niger state. The instrument was pilot tested and yielded the reliability coefficient of 0.76, 0.70 and 0.82 for PK, CK and PCK, respectively. Data collected were analysed using mean and standard deviation.

Results

Research Question one: What is the level of science teachers' Pedagogical Knowledge (PK)? To answer this research question, mean and Standard deviation was used and the analysis presented in Table 1

Table 1 Mean and Standard Deviation of science Teachers' Level of Pedagogical Knowledge (PK)

S/No		N	Mean	Std. Deviation	Remarks
1	Classroom management helps to create and maintain appropriate behaviour of students in classroom settings	200	3.50	1.33	High
2	Classroom management helps to increase stud academic engagement	200	3.47	1.30	High
3	Classroom management helps to enhance social behaviour	200	2.35	1.12	Low
4	Classroom management helps topromote active learning and student involvement.	200	3.47	1.35	High
5	Classroom management helps to identify important student behaviours for success	200	2.43	1.20	Low
6	Classroom management helps in preventing discipline problems.	200	1.40	1.40	Low
7	Classroom management establishes and sustains an orderly environment in the classroom.	200	3.49	1.30	High
8	Classroom management Increases meaningful academic learning and facilitates social and emotional growth among students.	200	3.55	1.32	High
9	Classroom management decreases negative behaviours and increases time spent on academic engagement	200	3.44	1.36	High
10	Chaotic classroom environment contribute to high teacher stress and burnout rates.	200	1.53	1.11	Low
11	Educational goals are statements that describe the skills that you should possess upon completion of a course or program.	200	3.49	1.30	High
12	Educational goals are statements that also describe competencies you should have gained upon completion of a course or program	200	2.50	1.12	Low

13	Educational goals are statements that describe the qualities that you should possess upon completion of a course or program	200	3.46	1.36	High
14	Educational goals involves identifying objectives and creating a plan for achieving them	200	3.55	1.29	High
15	Educational goals involves choosing attainable short-term goals and creating a plan to achieve those goals	200	3.52	1.39	High
	Grand mean		**3.50**		

Table 1 reveals the mean and standard deviation of teachers' level of Pedagogical Knowledge. The average mean of 3.00 and above was used as the benchmark for 'High' and the mean of less than 3.00 is considered 'Low.' Consequently, fifteen (15) items were listed, all of the items had mean scores which were between 1.40 and 3.55. Ten items were above the benchmark of 3.0 which indicates that the majority of science teachers in this population have high pedagogical knowledge while five items were below the 3.0 benchmark which indicates that a minority of science teachers in this population have low pedagogical knowledge. A grand mean of 3.50 which indicates that science teachers' pedagogical knowledge is high in this population.

Research Question Two: What is the level of science teachers' Content Knowledge (CK)? To answer this research question, mean and Standard deviation was used and the analysis presented in Table 2

Table 2: Mean and Standard Deviation of science teachers' level of Content Knowledge (CK)

S/NO		N	Mean	Std. Deviation	Decision
1	I know what content of my area of specialization is science is to be addressed in each session of the secondary school curriculum	20	3.54	1.16	High
2	I have sufficient repertoire of strategies for teaching Science subjects	200	3.31	1.70	High
3	It is true that Science concepts are related	200	3.43	1.11	High
4	Teachers should be able to diagnose and eliminate students difficulties and misconceptions in Science	200	3.44	1.19	High
5	Teachers should be able to apply Science concepts and laws to Natural laws and phenomena	200	2.24	0.88	Low
6	Science subject teachers should know how to design experiments for teaching and learning purposes as well as research	200	2.08	0.86	Low

7	It is important for teachers to gain mastery of essential concepts of school Science.	200	3.19	1.14	High
8	Teachers should be able to link Science concepts together	200	3.57	1.13	High
9	Teachers should be able to think about the content of secondary school Science subjects like subject matter experts	200	2.00	0.90	Low
10	Teachers should be able to develop a deeper understanding of the content of secondary school Science subjects.	200	3.43	1.11	High
11	An atom is defined as the basic unit of a chemical element	200	3.50	1.33	High
12	Molecules represent the basic unit of a chemical compound	200	3.47	1.36	High
13	The periodic table is a list or arrangement of all known chemical elements.	200	2.35	0.42	Low
14	A chemical reaction is a process in which one set of chemical compounds are transformed into another	200	3.47	1.35	High
15	A molecule is said to be chiral when its mirror image is not super imposable to the molecule itself	200	2.43	0.38	Low
	Grand mean		**3.54**		

Table 2 reveals the mean and standard deviation of teachers' level of Content Knowledge. The average mean of 3.00 and above was used as the benchmark for **'High'** and the mean of less than 3.00 is considered **'Low.'** Consequently, fifteen (15) items were listed, all of the items had mean scores which were between 1.35 and 3.57. Ten items were above the benchmark of 3.0 which indicates that majority of science teachers in this population have high content knowledge while five items were below the 3.0 benchmark which indicates that only a minority of science teachers in this population have low content knowledge. A grand mean of 3.54 which indicates that science teachers' content knowledge is high in this population.

Research Question Three: What is science teachers' level of Pedagogical and Content Knowledge (PCK)? To answer this research question, mean and Standard deviation was used and the analysis presented in Table 3

Table 3 Mean and Standard Deviation of Science Teachers' Level of Pedagogical and Content Knowledge (PCK)

S/No		N	Mean	Std. Deviation	Remarks
1	Technology should be integrated into Science classes	200	2.50	1.33	Low
2	Students should be helped to reflect on their Science learning strategies	200	2.47	1.36	Low
3	Students should be guided to discuss effectively during group work	200	2.35	1.12	Low
4	Cooperative learning helps learners to build their confidence	200	3.47	1.55	High
5	Allocation of tasks based on students abilities helps to carry all students along	200	2.43	1.38	Low
6	Problem solving skills can be improved by inquiry based instructions	200	1.40	1.12	Low
7	Bringing the 'abstract' concept of Science to life by visual and practical learning is very important	200	2.49	1.10	Low
8	It is important to break down larger tasks into achievable steps	200	3.56	1.32	High
9	The use of media establishes a direct connection with the digital world that learners inhabit	200	2.44	1.16	Low
10	A combination of discipline and reward helps to build an atmosphere of mutual respect	200	1.53	1.21	Low
11	General questions during learning encourages active class participation	200	3.49	1.40	High
12	Assignments should be given upon completion of every lesson	200	2.50	1.13	Low
13	Practical is an essential part of the Science curriculum	200	2.46	1.16	Low
14	Practical is an essential part of the Science curriculum	200	2.55	1.19	Low
15	Multiple choice questions allow assessment of full specification and rapid marking	200	2.52	1.17	Low

Grand mean 2.50

Table 3 reveals the mean and standard deviation of teachers' level of Pedagogical and Content Knowledge (PCK). The average mean of 3.00 and above was used as the benchmark for 'High' and the mean of less than 3.00 is considered 'Low.' Consequently, fifteen (15) items were listed;

all of the items had mean scores which were between 1.40 and 3.56. Ten items were below the benchmark of 3.0 which indicates that majority of cience teachers of this population have low pedagogical and content knowledge while three items were above the 3.0 benchmark which indicates that only a minority of science teachers in this population have high pedagogical and content knowledge. A grand mean of 2.50 which indicates that science teachers' pedagogical knowledge is low in this population.

Discussion of results

The finding of the study indicates that Science teachers in the said population have high Pedagogical Knowledge (PK). This result corroborates Ogunboyede (2014) in Odumosu (2018) who indicates that effective classroom teaching enhances students' performance. The implication is that science teachers have high content knowledge and this will translate to students having relatively good performance in science subjects. The findings also show that science teachers in this population have high content knowledge. This result corroborates the findings of (Festus, 2008) in Odumosu (2018) who reported high content knowledge among secondary school teachers. This implies that if students are taught by teachers of high content knowledge they could perform better. Collaborating this assertion are Olfos, Goldrine and Estrella (2014) and Popoola (2002) who found a strong correlation between teachers' pedagogical content knowledge and students' understanding in learning. The study is also in consonant with the works of Ishola and Udofia (2017); Ogar (2006) in Odumosu (2018) who affirmed that teachers' mastery of the subject matter is a component that determines the extent of students learning and achievement. The finding of this study also show that teachers in this population have low pedagogical and content knowledge. This corroborates with the findings of Mohamed *et al* (2021) indicating that teachers' face serious challenges in the implementation of PCK in classroom practices. There is, therefore, a need for more in-service training on raising teachers' PCK levels, which will eventually lead to improved teaching and learning.

Conclusion

The quality of chemistry teachers especially at the senior secondary education level cannot be compromised. The teachers at this level must have both the massage and the medium, because the shallow knowledge of teachers in chemistry content will not give the desired results. Given the findings of this study, it is logical to conclude that the teachers in this population have high pedagogical and content knowledge but have low pedagogical and content knowledge. If our goal is to encourage teachers to develop their PK, CK and PCK particularly in Science, it can only happen if teachers are exposed to proper training, conferences and workshops which will in turn improve the quality of teaching and learning.

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