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EXPLORING PHYSICS TEACHERS' KNOWLEDGE AND THE NEED OF PROFESSIONAL DEVELOPMENT IN ZAMFARA STATE, NIGERIA

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Abstract
Teaching is view as knowledge-rich profession. The quality of teacher basically depends on teacher Content Knowledge (CK) and Pedagogical Content Knowledge (PCK) and this contribute to students' academic performance. This study therefore assessed physics teachers' knowledge justified it on the need of professional development in Zamfara state. The target population comprised 40 physics teachers teaching physics in the secondary schools in Gusau educational zone. Simple random sampling technique was used to select 32 physics teachers. The instrument used for data collection was a paper pencil test tagged as Criterion Assessment Test (CAT). The CAT was used to assessed physics teachers content knowledge and pedagogical content knowledge. The instrument was validated, pilot tested and having reliability coefficient of 0.89 using Crombach's alpha coefficient. The findings revealed that physics teachers are averagely knowledgeable in terms CK and PCK to teach physics at secondary schools as their mean score is 57.6%. However, the significant different existed between qualified and unqualified physics teachers' knowledge; the significant different existed among physics teachers' knowledge based on experience, though it is between highly experienced and less experienced, moderately experienced and less experienced but no significant different between highly experienced and moderately experienced. There was no significant different between physics teachers' knowledge based on gender. The findings indicated the need of professional development for physics teacher in Zamfara state especially unqualified physics teachers and newly incoming teacher. It was recommended among others that professional development should be provided for physics teachers

Keywords: teacher' knowledge, professional development, teacher experience, teacher qualification, assessment.

Introduction

The meaning given to physics is as many as number of literatures in physics education. To some, it is the study of energy and matter (Abubakar, 2012; Gurikar, 2015). To others, it is the study of the universe and the characteristics of celestial objects such as the sun and the moon (European Physical Society (EPS), 2019). Physics comes from the Greek word 'physika' meaning natural taking its origin from the word 'physis' meaning nature. Therefore, the meaning of physics is nature. It is the study of energy and its interaction with matter. Because physics is much related to energy and energy plays key role in the matter. It is often considered as the fundamental science and queen of science. Its scope of study encompasses not only the behavior of objects under the action of given forces but also the nature and origin of gravitational, electromagnetic, and nuclear force fields. Its ultimate objective is the formulation of a few comprehensive principles that bring together and explain all such disparate

phenomena. Physics, as a science subject or discipline or course of study is taught or learned at the secondary school education level, up to tertiary level.

The general objectives of physics at the senior secondary school level as stated in the senior secondary school physics curriculum (Nigerian Educational Research and Development Council (NERDC), 2009) are:

1. To provide basic literacy in physics for functional living in the society.
2. To acquire basic concepts and principles of physics as a preparation for further studies.
3. To acquire essential scientific skills and attitudes as preparation for the technological applications of physics.
4. To stimulate and enhance productivity.

The aim behind these objectives is to improve standard of living of the country. In this modern age, technology has seen as a means of improving quality of life of people living in a society and physics is a key element require for technology driven. Physics is the backbone of modern society, driving technological advancement which transforms the lives (Ragini, 2023). Principles of Physics underpin essential technologies such as engineering, automobiles, modern construction, and telecommunication among others. The role of physics education in this modern age is importance (Pahalson & Nuhu, 2014). The 6 years snap-shot of the European economy shows that the physics based industrial have significant impact higher than many other broad industrial and business sectors (EPS, 2019). Physics based industries are those European economy where the use of knowledge of physics is critical for their existence. In this case secondary schools should better replace physics teaching by training in correct knowledge and skills.

Notwithstanding the importance of physics to the development of nations and technology, researchers have been troubled by students' poor academic performance. According to Amasuwa et al. (2022), science teachers are quite concerned about the persistently poor physics performance of senior secondary school pupils. In their study, Godwin and Okoronka (2015) also noted that although students had a favourable attitude towards physics but they performed poorly academically in the subject. According to Awodun (2021)'s study, over half of the sampled students passed the SSCE Physics exam between 2015 and 2018, earning grades ranging from A1 to C6. Given that not all of these students would continue their education during this time and that some would stray from the fields of study, it is implied that fewer than 50% of them would be encouraged to pursue degrees in science and technology. Consequently, society as a whole will be equally frustrated by students' poor performance in the subject as well as the students and their parents.

More so, the position of the teacher in teaching and learning is significant in the development of quality education. It is universally recognized that teacher is the key person in the success of educational system (Rindu & Ariyanti, 2017). In order to sustain quality education, teacher is much needed. Kaur (2019) stated that the role play by teacher has becomes very important component and in fact it can be said they are our nation builder. The basic role of a teacher is to create very interesting classroom for the students and to manage and control every challenges surrounding the teaching and learning. In particular, teacher should be able to take control on the interaction between the components of teaching such as objectives, contents, learning methods, teaching resources, organization of instruction, the process of learning and evaluation. Chenrui (2020, p. 1) posited that "teaching is not everybody cup of tea". This means teaching should be professionalized. Teacher with professional ability is a relevant factor in preparation of effective methodical plans,

organization and carry out work on student learning (Murati, 2015). Therefore, a professional teacher required to possess certain knowledge and skills which will make them efficient in their teaching profession. When there is concern about students' poor academic achievement, the research used to focus on school and students factors. But the achievement of students rooted from teacher quality. With the low quality of the teacher, it will have impact on achievement and learning process for students (Kanya et al., 2021). The teacher of higher quality must be knowledgeable as teaching is a knowledge-rich profession. The teacher who possesses good knowledge and information about the concern field can easily promote students' academic achievement (Khan et al., 2016).

There is no doubt that the quality of a teacher majorly depends on their knowledge of what to teach "Content Knowledge (CK)" and how to teach a particular concept "Pedagogical Content Knowledge (PCK)". CK is the teacher's cognitive understanding of the subject matter. It is a fact that nobody can teach what he does not understand (Adediwura & Tayo, 2007). According to Jacob et al. (2020), CK generally refers to the facts, concepts, theories, and principles that are taught and learnt in specific academic subjects or courses in schools. It embodied all the knowledge and information teachers teach and that students are expected to learn in a particular subject. It represents the teacher's understanding of the subject matter taught. Therefore, CK is also known as subject content knowledge, which covers all the concepts related to a teaching topic. In actual learning, teachers should not only demonstrate skilful CK but should also include the ability to guide students to meaningfully acquire the contents of the knowledge. This demonstrates the importance of PCK.

According to Jacob et al. (2020), PCK is the knowledge needed to make subject matter accessible to students. As noted by Garba and Hussaini (2024), having the CK is different from having the skills of teaching in a way to make such content accessible to students. PCK involves the teacher's competence in delivering a concept in an effective and efficient manner. Therefore, PCK is the knowledge that integrates the knowledge of a subject with pedagogical knowledge for teaching the subject. It is an understanding of how to present a subject and make it comprehensive for students. It is assumed that teachers with a B.Sc. without educational training will have only CK, while those with a B.Sc. Ed. or B.Sc. and PGDE will have both CK and PCK. Unexpectedly, the study conducted by Williams et al. (2018) revealed that teachers with B.Sc. demonstrated higher CK and PCK than teachers with B.Sc. Ed. This implies that the experience in teaching by the teacher may be accounted for the acquired PCK. As observed by Awodun (2021), challenging facing physics as a subject is inadequate for CK and PCK by physics teachers. To improve students academically, physics teachers need to be well-trained in these two areas of knowledge. The literature has revealed that CK and PCK predict teachers' effectiveness and have a significant relationship with students' academic performance (Ogundeji et al., 2021; Suglo et al., 2023; Williams et al., 2018). Biwai et al. (2020) stated that a professional physics teacher is a professionally prepared teacher in terms of contents and method of teaching the subject.

Teacher Professional Development (TPD) can be defined as the process designed to enhance the quality of teaching (AbdulRab, 2023). It is a lifelong process that begins with the initial preparation that teachers receive and continues until retirement. TPD seems to be important because teachers are the most important agents for change in the educational system. TPD is a strategy that schools adopt to ensure that teachers continue to strengthen their practice throughout their careers (Mizell, 2010). TPD should be a continuous process because students' needs and teaching strategies change from time to time. The importance of continuous

professional development for teachers in secondary schools lies in the fact that it helps them improve their professional and instructional practices (Banik & Saha, 2023). TPD is closely related to education reform because it enhances students' achievement and the quality of education (Tran et al., 2020). The categories of TPD are formal processes such as conferences, seminars, workshops, collaborative learning among members of a work team, a course in an institution, and informal processes such as discussion among colleagues, independent reading and research, observation of a colleague's work, and learning from peers through a marking coordination exercise. The form of TPD that is usually available in schools is in-service training, which consists of workshops and short courses that would offer teachers new information on a particular aspect of their work. Despite the importance of TPD in improving the quality of teachers by updating their knowledge in their profession to improve students' achievement, Chu et al. (2016) observed that the existing literature provided unsatisfactory results for professional development specifically designed for 21st century skills teaching, especially for in-service teachers.

No matter how good the training received by pre-service teachers in the school, it cannot be expected to prepare teachers for all the challenges they will face throughout their career (OECD, 2009). This means that in-service teachers require continuous professional development to maintain high quality of teaching. Taking professional development as priority is to enhance teachers' knowledge and skills. Among others models to promote and support professional development identified by Cetin and Bayrakci (2019), the observation and assessment is the target of this study. The authors explained this model of professional development as the model that based on the feedback of the teachers from the other experts' observation and the feedback can be found in the literatures. Chu et al. (2016) stressed that to support teachers in the adoption and development of 21st century skills of teaching, there is need to first highlight skills and capacities that teachers lack. When this is done, the ways to strengthening the teachers in those skills should be suggested to keep them in line with contemporary educational development. This shows that professional development is important to equip teachers with the necessary skills to achieve the 21st century education (AbdulRab, 2023). The study conducted by Sodangi et al. (2022) revealed that science and mathematics teachers in Zamfara State are novices in professional development, meaning they have not been participating in it, and they identified content knowledge and pedagogical knowledge as the two majors needed area for professional development. Secondary school principals also acknowledged their inability of promoting professional development due to some challenges such as inadequate funding, a lack of support from higher authorities, and a lack of motivation among the teachers (Sodangi et al., 2023). It is therefore necessary to clarify this with research and to particularly determine if physics teachers have deficiency in the subject content and pedagogical knowledge because some teachers will have good intentions in mind but may cause damage to students or the system due to lack of training and skills. Hence, this study focuses on physics teachers' knowledge (Cnotent knowledge and Pedagogical content knowledge) as the key factor of teacher professionalism.

The teachers' demography was considered in this study as Biwai et al. (2020) stated that professional teachers' qualification, experience and gender are very imperative to the formulation and successful implementation of educational policies in any country. The two main themes underlying this study are improving students' outcomes and teachers' professionalism. Knowing the strength and weakness of the teachers' knowledge could give the direction on the area where professional development is needed. Karlberg and Bezzina (2022) provided that professional development emanated from within the profession allowing

practices that are more collaborative and focused on the identified needs. Biwai et al. (2020) stated that a professional physics teacher is a professionally prepared teacher in contents and method of teaching the subject.

Research Objectives

The following are the objectives of the study:

1. Find the secondary schools physics teacher's Knowledge (content and pedagogical content Knowledge) for teaching Physics in Gusau metropolis.
2. Determine teachers' knowledge base on qualification.
3. Determine teachers' knowledge base on experience.
4. Determine teachers' knowledge base on gender.

Research Questions

The following questions guided the study;

1. What is the level of Physics' teachers' knowledge for teaching Physics in Gusau?
2. Does physics teachers' knowledge differ with respect to their qualification?
3. Does teaching experience determine teachers' knowledge?
4. Is there any distinction between the physics teachers' knowledge based on their gender?

Research Hypotheses

The following Hypotheses were formulated and tested

$H0_1$: There is no significant different between the knowledge of qualified and unqualified physics teacher.

$H0_2$: There is no significant difference among the knowledge of high, moderate, and less experience physics teachers.

$H0_3$: There is no significant difference between the knowledge of male and female physics teachers.

Methodology

The research design adopted in this study is quantitative survey; it is used to investigate physics teachers' knowledge (content and pedagogical content knowledge) for teaching Physics in Gusau metropolis, Zamfara state. The target population comprises 40 physics teachers teaching physics in the secondary schools. A simple random sampling technique was used to select 32 teachers to participate in the study. This ensures that the sample is unbiased and represented the entire population of secondary school physics teachers. The sample comprises 26 male and 6 female physics teachers. The instrument used for data collection was a paper pencil test tagged as Criterion Assessment Test (CAT). This was used as a requirement to qualify physics teacher. The instrument has three sections A-C. Section A consisted demographic data of the physics teachers. Section B is physics questions of multiple choices from concept of mechanics. The concept of mechanics is considered because it is cut across every other concept in physics. Physics teacher that don't understand this concept will surely have problem in teaching other concepts in physics. Section C comprised questions on the method of teaching which are matching type.

The contents of the instrument were ensured to be validated by three experts in the department of science education. This was done to ensure clarity, comprehensibility, relevance and alignment with research questions being raised. A pilot test was carried out in Kaura Namoda which is another educational zone in zamfara state. 10 physics teachers were

randomly selected and the instrument was administered to them. The reliability of the instrument was assessed using Crombach's alpha coefficient, and the coefficient of 0.89 was obtained, this indicate reliability of the instrument. The researchers went to each school and administered the test to physics teachers in the school. The teachers were allowed to use their time to finish the test and retrieved their test script by researchers thereafter. The respondents were rated based on their performance in the test. Teachers scored from 70% and above were rated highly potential physics teachers, those scored 50% - 69% were rated potential physics teachers, those who scored 40% - 49% were rated fewer potential physics teachers and those who scored 39% and below rated non-potential physics teachers. The instrument personally administered to respective physics teachers sampled in their various schools. The data collected were analysis using percentage, mean, t-test and ANOVA.

Results

The results of the analysis presented in accordance with research questions and hypotheses.

Research Question One: What is the level of Physics' teachers' knowledge for teaching Physics in Gusau?

Table 1:

Mean score on Physics teachers' knowledge for teaching physics

Number of physics teachers	N	Mean score	Percentage (%)
32	25	14.4	57.6

N = Obtainable score

The finding shows in the table 1 indicate that physics teachers were potential to teach physics since their mean score 14.4 (57.6%) is greater than 50% but less than 70%.

Research Question Two: Does physics teachers' knowledge differ with respect to their qualification?

Table 2:

Mean score on Physics teachers' knowledge for teaching physics based on qualification

Teachers Category	Number of physics teachers	N	Mean score	Percentage (%)
Qualified	10	25	19.6	78.4
Unqualified	22	25	12.1	48.4

N = Obtainable score

The findings in the table 2 shows that qualified physics teacher perform excellently with the mean score of 19.6 (78.4%), this rated them highly potential. Unqualified physics teacher were rated less potential as their mean score was 12.1 (48.4%). This shows that they are differ in knowledge for teaching physics.

Research Question Three: Does teaching experience determine teachers' knowledge?

Table 3:
Mean score on Physics teachers' knowledge for teaching physics based on teaching experience

Teachers Category	Number of physics teachers	N	Mean score	Percentage (%)
Highly experienced	10	25	16.6	66.4
Moderate experienced	14	25	15.6	62.4
Less experienced	8	25	9.8	39.2

N = Obtainable score

The analysis in table 3 revealed that highly experienced and moderately experienced physics teachers were rated potential as their mean scores are 16.6 (66.4%) and 15.6 (62.4%) respectively. Less experienced physics teachers were rated non-potential physics teachers as their mean score is 9.8 (39.2%). This shows that teaching experience determine the knowledge possess by physics teachers for teaching physics.

Research Question Four: Is there any distinction between the physics teachers' knowledge based on their gender?

Table 4:
Mean score on Physics teachers' knowledge for teaching physics based on gender

Teachers Category	Number of physics teachers	N	Mean score	Percentage (%)
Male	26	25	14.2	56.8
Female	6	25	15.3	61.2

N = Obtainable score

It was revealed in table 4 that both male and female were rated potential as their mean scores are 14.2 (56.8%) and 15.3 (61.2%) respectively but knowledge possess by female physics teachers is higher than that male counterpart.

Testing of Hypotheses
$H0_1$: There is no significant different between the knowledge of qualified and unqualified physics teacher.

Table 5:
t-test analysis of physics teachers' knowledge based on qualification

Teachers Category	N	Mean score	SD	Df	T	Sig.
Qualified	10	19.6	3.44	30		

					4.508	0.000
Unqualified	22	12.1	4.71			

Table 5 shows the comparison between qualified physics knowledge and unqualified physics knowledge. It ws revealed that t = 4.508 and P<0-05, this implies that the hypothesis was rejected that is there is significant different between the knowledge of qualified physics teachers and unqualified physics teachers.

H0₂: There is no significant difference among the knowledge of high, moderate, and less experience physics teachers.

Table 6:
Mean score on Physics teachers' knowledge for teaching physics based on teaching experience

Teachers Category	N	Mean score	SD	Df	F	Sig
High experienced	10	16.6	5.84	31		
					4.849	0.015
Moderate experienced	14	15.6	5.17			
Less experienced	8	9.8	3.09			

From table 6, it was revealed that significant different exist among the knowledge of high experienced, moderate experienced and less experienced physics teachers since F = 4.849 and P<0.05. This shows that the hypothesis was rejected. Post Hoc Test shows where significant different exist.

Post Hoc Test
Table 7:
Multiple comparison among high, moderate and less experience physics teachers

Compare variables	Mean difference	Sig	Remark
High experience vs. Moderate experience	1.02857	0.872	Not significant
High experience vs. Less experience	6.85000	0.019	Significant
Moderate experience vs. Less experience	5.82143	0.034	Significant

Table 7 shows the multiple comparisons among the knowledge of high experienced, moderate experienced and less experienced physics teachers. It was revealed that there is no significant different between the knowledge of high experienced and moderate experienced physics teachers as P>0.05; There is significant different between the knowledge of high experienced and less experienced physics teachers as P<0.05; and there is significant different between the knowledge of moderate experienced and less experienced physics teachers as P<0.05.

H0₃: There is no significant difference between the knowledge of male and female physics teachers.

Table 8:
t-test analysis of physics teachers' knowledge based on gender

Teachers Category	N	Mean score	SD	Df	T	Sig.
Male	26	14.2	5.25	30	-0.432	0.669
Female	6	15.3	7.29			

It was revealed in table 8 that no significant different exist between the knowledge of male and female physics teachers since t = -0.432 and P>0.05. This implies that the hypothesis was accepted.

Discussion

The findings in table 1 indicate that physics teachers in Gusau, Zamfara state are averagely in terms of the content and pedagogical content knowledge they possess. But this knowledge might not be enough for them to be excellently in discharging their duty since their performance is less than 70%, especially for the teaching and learning of the 21st century skills. This support the observation by Awodun (2021) that the challenging facing physics as a subject is inadequate for CK and PCK by physics teachers. Consequently, the finding of Dusabimana and Mugabo (2022) revealed that physics teachers were found not effectively implementing current curriculum that requires inquiry practice. Therefore, teacher's knowledge of the subject matter, attitude to work and teaching skills have significant role in promoting students' academic performance (Adediwura & Tayo, 2007; Khan et al., 2016).

By considering the qualification of teachers, the qualified physics teachers are knowledgeable more than unqualified physics teachers and the different is significant. This could be as a result of pedagogical knowledge qualified physics teachers received during their training in school which unqualified teachers do not. Contrary to this finding of the study conducted by Williams et al. (2018) which revealed that teachers with B.Sc. demonstrated higher CK and PCK than teachers with B.Sc. Ed. Biwai et al. (2020) also found that significant different does not exist between professional teachers qualification on the use of teaching method. The authors did their investigation through the opinion of the teachers on the use of teaching method but this present study use the paper written test to find out the pedagogical knowledge of the teachers. This could be source of difference in the results.

Furthermore, the findings revealed that significant exist among highly, moderately and less experienced physics teachers. This significant different exist between highly experienced and less experienced; between moderately experienced and less experienced while no significant different between highly and moderately experienced physics teachers though the knowledge possess by highly experienced teachers is more than moderately experienced teachers. With this indication, the years spend in the service determine the experience gained and arise to more knowledge. This finding is in line with the finding of Biwai et al. (2020).

The result of finding on gender indicated that no significant different between male and female physics teachers' knowledge. Though, female physics teachers possess higher knowledge than male physics teachers. This finding is also corresponding to the finding of Biwai et al., it means cognitive knowledge does not determine by gender differences.

Implication of Findings

The major implication of the findings is the direction and the area of the need of professional development for physics teachers in senior secondary schools in Gusau and Zamfara as a whole. Since the academic performance of students in physics depends on physics teachers' knowledge in content knowledge and pedagogical content knowledge (Ogundeji et al., 2021; Suglo et al., 2023; Williams et al., 2018), physics teacher need to be excellently in possession of these knowledge. This study revealed that knowledge of physics teachers in these two aspects is not enough for excellent achievement in students' academic performance. This implies that physics teachers in secondary schools in Gusau, Zamfara state need professional development on the subject contents and pedagogical knowledge to promote their quality and academic performance of their students since AbdulRab, (2023) noted that TPD is designed to enhance the quality of teaching. It is also in line with the findings of Sodangi et al. (2022) that science and mathematics teachers in Zamfara state have not being participating in TPD and identified CK and PCK as two major area need to be focused on TPD. There is also an indication that teachers without teaching requirement and those with teaching requirement but less experience need to be more focus on this professional development.

Conclusion and Recommendation

From the findings, it was concluded that physics teachers in secondary schools in Gusau, Zamfara state have insufficient content knowledge and pedagogical content knowledge to make students perform excellently. This indicates that there is need for professional development for physics teachers in this area to improve their quality and students academic performance. It was recommended that regular workshop should be organized for physics teachers on the area identified and this same workshop should always organize for the newly recruited physics teachers. The highly experienced physics teachers should be motivated to remain in service in order to mentor less experienced physics teachers. Also, government should always support schools to make possible organization of workshop to avoid challenges identified by principals in the study conducted by Sodangi et al. (2023).

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