

## Exploring Pedagogical Content Knowledge of Teachers: A Paradigm for Measuring Teacher's Effectiveness

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### Abstract

Educators' pedagogical content knowledge (PCK) is crucial to the development of effective teaching practises and the implementation of effective curriculum. This understanding will serve as a guide for appropriate pedagogical thinking and decision making. Classroom observations, content representations (CoRes), pedagogical and professional experience registries (PaP-eRs), structured and semi-structured interviews, stimulated recall interviews, artefacts from teachers' tasks, concept mapping, reflective journals, tests, and lesson observations are just a few of the complex and specialised procedures required to measure PCK. Paper and pencil assessments have been hailed as a potentially useful instrument for determining PCK due to the fact that they are a trustworthy, objective, and valid procedure that may be utilised with a greater volume of samples. The easiest way to obtain PCK data for triangulation purposes from several sources is to use a combination of these approaches.

**Keywords:** pedagogy; content knowledge; pedagogical content knowledge; teacher's effectiveness; teacher education

**How to cite:** Ahmed, Abiola T., Shogbesan, Yusuf O. (2023). Exploring Pedagogical Content Knowledge of Teachers: A Paradigm for Measuring Teacher's Effectiveness. *Pedagogi: Jurnal Ilmu Pendidikan*, 23(1): pp. 64-73, DOI: <https://doi.org/10.24036/pedagogi.v23i1.1540>



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## INTRODUCTION

Educators are urged to make systemic changes to their teaching methods in order to bring about the kind of sustainable growth that society requires, especially in Nigeria, both now and in the future. Instead than depending on teachers with little more than a piece of paper to prove their credentials, schools should give top priority to recruiting certified teachers who can make lessons interesting, easy to understand, and ultimately more beneficial for their students. The most effective teachers are those who can successfully convert their knowledge of the material and the strategies they employ into the development of their students' learning. In order to transform material and pedagogy into applicable concepts, teachers need to have a solid grasp of both. The Next Generation Science Standards (Council, 2013) were one set of standards that recognise the importance of teachers having a deep familiarity with their subject matter, as well as an awareness of how their students learn and the range of methods available to them for fostering that growth. Recognizing the critical role that education and training play will help find teachers who have the right skillsets in the classroom (Baran & Correia, 2014). Evidence-based, model-based, discourse- and argument-based, with an interweaving of practises, ideas, and concepts; and where effective education begins

with experienced instructors; these are the hallmarks of modern, reform-based classrooms, as evidenced by these standards (Dimitriadis, 2012; Shulman, 1987)

Taking into account the characteristics of students and the status of the educational system, it is a huge effort to bring the technique of teaching and learning into sync with the reality of the 21st century. When considering the present and the future of education, it is hard to ignore the importance of teachers' subject-matter expertise. Hence, it is assumed that modern educators would have a deep well of pedagogical content knowledge (PCK), content knowledge (CK), and pedagogical content knowledge (PCK). The 21st century's demand for effective educators may be met by those who have a breadth and depth of knowledge in the areas of content, pedagogy, students, the learning context, language, and curriculum. Also. Teachers' decisions and behaviours in the classroom are influenced by the educational knowledge they possess (PCK).

### **Concept of Pedagogical Content Knowledge (PCK)**

The term "pedagogical content knowledge" (PCK) refers to the integration of subject matter expertise with teaching expertise to structure training in a way that caters to a wide range of student interests and skill levels. It's called "content and pedagogy fusion" when these two elements come together like this (Atay, Kaslioglu, & Kurt, 2010). What we mean by "pedagogical content knowledge" (PCK) is the ability to organise, plan, analyse, and present content in such a way that it is most likely to be understood by students in a given context. This understanding is achieved through a combination of rich pedagogical knowledge and content knowledge. PCK as the combination of rich pedagogical knowledge and content knowledge (J. Loughran, Berry, & Mulhall, 2012). PCK was also as information that can only be digested by educators and that aids in communicating what educators know, what educators should know, and how educators may grow their knowledge base (E. J. Park, 2015). Commonly held knowledge (PCK) is a type of expertise that can only be processed by those who make a living educating. A key component of PCK is identifying and successfully resolving students' preconceived notions and misconceptions across a variety of contexts of instruction and learning (Garritz & Ortega-Villar, 2012; Shulman, 1987)

Pedagogical content knowledge is the sum of a number of interrelated characteristics, including expertise in the subject area, familiarity with students and their misconceptions, familiarity with the curriculum, and familiarity with general pedagogy. In order to create individuals who are able to contribute meaningfully and positively to the solution of problems that threaten man's existence on planet earth, it is necessary to have a reservoir of knowledge of good teaching practise and experience, which is what is meant by "possessing competent knowledge" (PCK). Shulman's concept relies heavily on knowledge representation and knowledge presentation. Planning the lesson around who will be taught, what will be taught, why it will be taught, when it will be taught, and how it will be taught is all part of the knowledge representation process. Knowledge presentation, on the other hand, describes everything a teacher does in class to make sure pupils understand and apply what they're learning. It includes all of the instructor's analogies, examples, and demonstrations that are woven throughout the course content to help students learn effectively.

When teachers have pedagogical knowledge (PK), they are better able to create a classroom environment where students may learn and grow. What makes a good teacher great is not just general knowledge, but deep expertise in the subject matter they teach (Kultsum, 2017). The instructor's area of competence may be described in terms of both the subject matter and the teacher's familiarity with it using the PCK method. It is the teacher's responsibility to ensure that students have a thorough understanding of the material being covered in class. This includes ensuring that students have a firm grasp on key concepts, problems, and issues, as well as ensuring that presentations are tailored to their individual learning styles and interests (Hashim, Saili, & Noh, 2015). Magnusson, Krajeik, & Borko (1999) presented a more in-depth description of the notion of PCK by claiming that it consists of five components: attitudes towards teaching, curriculum knowledge, assessment knowledge, student knowledge of topic taught, and instructional techniques

knowledge. First and foremost, the educator needs to be well-versed in the subject matter, but also possess the flexibility and adaptability necessary to transform that knowledge into "forms that are pedagogically powerful and yet, adaptive to the variations in ability and background presented by the students," To be more specific, an educator has to be well-versed in their subject area and yet possess the versatility and adaptability necessary to transfer that information into "forms that are meaningful" to their students (Shulman, 1987).

Due of its importance, subject knowledge cannot be disregarded throughout the implementation of the instructional process (Yusri, Rahimi, Shah, Wah, & Hassan, 2012). But, only well-qualified and experienced educators will have the ability to transform classroom content into forms that pupils would be able to grasp (Chapoo, Thathong, & Halim, 2014). For the purpose of creating a topic domain that is accessible to students, Shulman (1987) established the concept of pedagogical content knowledge (PCK). It was an effort to correct teachers' inefficient methods of instruction. The level of a teacher's pedagogical content knowledge (PCK) is strongly correlated with how well they are able to impart information to their pupils (Hashim et al., 2015).

### **Effective Teachers in the 21<sup>st</sup> Century**

Changes in the way that information and education are organised laid the groundwork for the information and knowledge society that has emerged in the 21st century. Educational practises and procedures must continue to evolve because of the changes already taking place in other sectors of the economy. The worldwide shift to a knowledge-based economy has resulted in a heightened focus on improving educational institutions and, in particular, the calibre of educators. With the continuous shift to a knowledge-based economy in the 21st century, the calibre of teachers in the classroom is one of the most influential variables shaping the educational system. The quality of a country's educators is the most crucial component in determining the efficacy of its educational system. Hence, it is crucial that our schools have successful instructors, as it is the schools with the effective teachers that will foster the traits in their pupils that will enable them to succeed in the present and in the future. However, it's crucial that we have competent educators working in our classrooms.

Teacher effectiveness, defined as the ability to have a substantial and long-lasting effect on one's students, is crucial to the success of any school. This is because teachers often have a significant impact on their pupils, affecting how they learn, how much they learn, and how they interact with one another and the environment. Stronge (2018) argues that it is crucial for educators to know how they can best help their pupils succeed in the classroom. As an example, these outcomes include improved school attendance, motivation, and performance. All of the aforementioned behaviours are essential components of teaching and may be used as criteria for identifying a great educator. The importance of teachers who are well-versed in both the art and science of education was emphasised by Marzano (2007).

Notwithstanding the difficulty, several researchers have tried to define teacher effectiveness in terms of their students' academic achievement and positive assessments from their peers, superiors, and administrators (Stronge, 2018). Based on its meta-analysis, categorises the characteristics of an excellent educator into the six areas discussed below. The following list details these areas: Topics include: what makes a good teacher, how to run a class, what to teach, how to teach it, how to monitor student progress, and how to improve as a teacher.

A successful educator must have the following characteristics: strong communication skills; an understanding of how students learn; proof of qualifications; familiarity with the subject matter; and sufficient classroom experience (Williams & Ritter, 2010). According to Williams, a teacher's personality, the amount of engagement with pupils, excitement, inspiration, devotion to teaching, and reflective practise are all qualities that make up a good educator

The efficiency of chinese educators was also the subject of a qualitative research by Lui and Meng (2009). Participant feedback was collected and subjected to a thematic analysis. The following recurrent concepts were uncovered. They include (Williams & Ritter, 2010): teacher

ethics; professional skills; professional development and teacher Effects: characterized by student test scores.

The framework for effective teaching that was provided by Strong (2018) is detailed in a number of ways that may be utilised to operationally characterise a teacher's efficacy. The concept of a successful educator was the focus of this framework. This framework is provided in the figure 1 below:

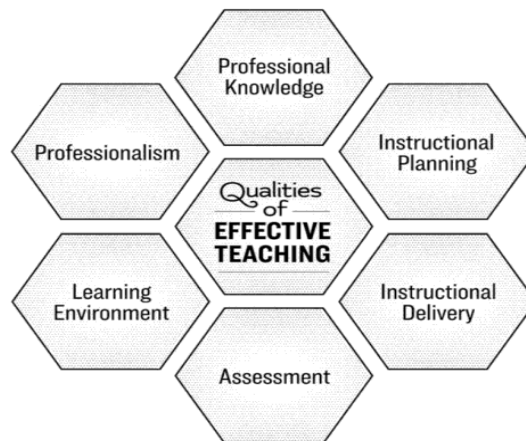


Figure 1. Framework for Effective Teaching (Stronge, 2018)

It is clear from the following image that professional expertise, instructional preparation and delivery, evaluation, and an understanding of the learning environment are all indicators of excellent teaching. So, in order to be an effective teacher, one needs to constantly increase their level of competence in all areas of pedagogical content knowledge and the subjects they teach (Magnusson et al., 1999). Knowledge of the subject matter (called 'content knowledge'), general knowledge about teaching (called 'pedagogical knowledge'), and knowledge about how people learn and how to teach in a specific discipline or substantive domain (called 'pedagogical content knowledge') are also necessary for a professional educator (Mehta & Doctor, 2013).

A teacher's professional knowledge should contain not just knowledge of pedagogy and curriculum, but also understanding of pupils and the culture and community in which they live. Expertise in pedagogy and curriculum design should round out a teacher's professional expertise (Stronge, 2018). As a guide for effective pedagogical thinking and decision making, teachers need a firm knowledge of the facts, concepts, principles, and procedures of the subject they teach. This specialised pedagogical subject knowledge encompasses the teacher's understanding of how pupils learn or fail to learn, as well as the teacher's use of highly topic-specific, person-specific, and situation-specific practises (Van-Driel & Berry, 2017). Student comprehension of the instructor's pedagogical practises is also part of this pedagogical content knowledge.

Given the importance of effective educators, it is crucial that they get consistent support in developing their own expertise in the areas of content knowledge, pedagogical knowledge, and pedagogical content knowledge. Educators of the 21st century need to focus not only on bringing their subject matter up to date, but also on adjusting their pedagogical approaches to reflect the needs of their students and the reality of the modern classroom. Both the topic and the approach are equally sound. The talents of pupils and the results of their education are directly proportional to the quality of their teachers and the instruction they get.

## DISCUSSION

### PCK of Teachers and Students Learning Outcome

An effective teacher is one who causes student improvement on core content educational outcomes. Teachers are one of the most important factors that influence students' understanding and performance (Lumpe, 2007). Since the improvement in student learning outcome is the central aim of schooling, it is necessary to identify which teacher behaviors and attributes contribute to significant student gains. One of such attributes of the teacher is the pedagogical content knowledge

of the teacher. The most crucial elements in students' academic performance in today's classrooms are teachers' subject-matter expertise and pedagogical understanding conceptualized as Pedagogical Content Knowledge (PCK) (Darling-Hammond, 2000). PCK refers to the knowledge that teachers acquire over time and through experience on how to present a certain subject in a particular manner in order to increase student understanding (Cooper, Loughran, & Berry, 2015).

However, PCK is an aspect of knowledge that is necessary for teachers to deliver lesson effectively and efficiently to students. A deficiency in any of PCK components is bound to affect teachers' effectiveness and consequently influence students' performance. It should be noted that the performance of students usually serves as a yardstick to measure teaching effectiveness.

Although several other factors have been attributed to poor performance in students learning outcome, these factors have been identified to include lack of qualified teachers, poor teaching method, and lack of teaching experience among others. Majorly, the causes of dwindling students' performance may be due to the ineffectiveness on the part of the teachers. The lack of qualified teachers, ineffective methods of teaching, lack of teaching experience, the non-use of instructional media had been identified and perceived as the causes of poor performance of students in Chemistry (Ojukwu, Patel, Stephenson, Howden, & Shawe, 2016). Causes of students' poor performance in Chemistry to teachers' inadequate knowledge of teaching curriculum on which students learning is based, as well as teachers' lack of adequate knowledge of the subject matter (Okorie & Akubilo, 2013).

Moreover, there was study found out that there is a low level of relationship of the PCK elements on students' achievements in al-Quran tajweed (Hashim et al., 2015). The PCK elements explored include content knowledge, pedagogical knowledge, knowledge of learners, curriculum knowledge and teachers' al-Quran knowledge. Hence, it is imperative for teachers to possess adequate knowledge of content which is also refers to as subject matter in some cases and knowledge of teaching curriculum which students learning is based. These two aspects are components of PCK as suggested in Magnusson et al. (1999) models of PCK. One possible strategy for improving the quality of instruction by the teachers is to improve PCK. Poor content knowledge of teachers, including poor PCK is a factor that contribute to learners' poor performance in mathematics (Adler & Venkat, 2014)

### **PCK: A Paradigm for Measuring Teacher's Effectiveness**

There were a "art" of teaching and a "science" of teaching as two factors that contribute to effective education. The art of teaching is harder to evaluate because it typically uses covert structures. Although it may seem unimportant at first, the ability to instruct others is crucial. One of the most essential yet difficult-to-understand parts of professional knowledge is professional content knowledge (PCK), which may be observed in both the art and science of teaching. It is possible to see PCK in both the art and the science of education (Chan & Hume, 2019; Gess-Newsome, 2015). Moreover, the effectiveness of educators may be crucial, but it depends on factors that are challenging, if not impossible, to measure (Lavy, 2016). Teachers' pedagogical subject knowledge is difficult to conceptualise without first grasping foundational phenomena like the teaching-and-learning process, the nature of knowledge, and the ways in which instructors actually use their own expertise in the classroom.

Measuring PCK is challenging because it requires evaluators to make inferences about tacit procedural knowledge. Although it is well known that the teacher's knowledge and other characteristics are also significant factors in determining the effectiveness of instruction, claim that the effectiveness and quality of teaching were evaluated solely based on the observational aspect of the classroom setting (Muijs et al., 2014; Seidel & Shavelson, 2007)

Several approaches have been created to evaluate teachers' PCK based on classroom observations. An educator's PCK can be measured using a model developed by Korthagen, Loughran, & Russell (2006). The many aspects of teachers' pedagogical subject knowledge have also been studied by Park and Oliver (2008). John Loughran and his team developed two methods: Content Representation (abbreviated as "CoRes") and Pedagogical and Professional-experience

Repertoires (abbreviated as "PaP-eRs"). These two methods constitute one of the most popular suggestions for evaluating PCK (J. Loughran, Mulhall, & Berry, 2008).

When evaluating a teacher's PCK, the Content Representation (CoRe) is used to evaluate not only their subject-matter expertise, but also their familiarity with the lesson's objectives, instructional strategies, and representations, as well as their ability to monitor and adjust the lesson's progression based on students' progress in real time (Korthagen et al., 2006; J. J. Loughran, 2004). CoRe has been shown to be useful in pre-service science teacher education by supporting prospective educators in understanding the concept of "PCK" and creating their own representations of teaching in a certain subject area. Pre-service teachers were asked to generate their own examples of CoRes by an educator (J. Loughran et al., 2008). This was done after the future educators had seen and reflected on CoRes developed by instructors with ten or more years of experience. This was accomplished after the future educators had viewed and remarked upon similar materials developed by educators with ten or more years of experience in the classroom. Loughran et al. (2008) suggested that a more nuanced perspective on knowledge, how to transmit scientific information, and how to educate for comprehension may be acquired by placing a focus on PCK while employing CoRe to frame the thinking about the linkage between content and pedagogy.

Despite the existence of these two models at today, the model produced by Magnusson et al. (1999) continues to be the one that is used most frequently in the published research on PCK, as seen by some of the reviews that have been cited most frequently (e.g. Chan & Hume, (2019); Van-Driel & Berry (2017)). And yet, one of the most often used forms of this model is the one proposed by Park and Oliver (S. Park & Oliver, 2008) who have focused on quantifying the interactions between the five main components of Magnusson's PCK model (e.g., S. Park & Suh, 2015) Based on their analysis of Magnusson's PCK model, the Pack concludes that the many forms of knowledge contained within it may interact with one another, increase at different rates, and be dependent on the content (Bravo & Cofré, 2016).

According to Chan and Hume's (2019) review of studies conducted on PCK assessment in the last ten (10) years, researchers have often used many data sources to learn about teachers' PCK. This was discovered as a result of their investigation. Examples of studies that employ such methodologies are Jüttner and Neuhaus (2012), Rollnick (2017), Coetzee, Rollnick, and Gaigher (2022), and Reynolds and Park (2021). Some of these instruments have been used to assess and record the PCK of secondary and elementary school teachers (see, for example, Bravo & Cofré, 2016; Coetzee et al., 2022; J. J. Loughran, 2004; Padilla, Ponce-de-León, Rembado, & Garritz, 2008; Rollnick, 2017) The most important takeaway from these efforts to standardise measurement is the belief that observing teachers in action and conducting interviews with them to learn about their pedagogical decisions are the most effective ways to characterise professional content knowledge. These empirical investigations mostly result in this conviction. Many analyses have therefore concluded that combining information from several sources is the most reliable way to quantify and explain PCK (e.g., Chan & Hume, 2019)

Questionnaires seem to be a valid research tool within the confines of topic-based PCK studies. In an effort to construct a tool for assessing PCK-related accomplishment in science teacher training, Kratz & Schaal (2015) establish subscales with domain-specific scales and adequate internal consistency. So, the researchers will be able to develop a tool for gauging performance in areas relevant to PCK. Nevertheless, the authors employ preexisting measures and tailor the subscales they use using component analysis in order to assess general attitudes towards science education. The components of (a) "knowledge about students' grasp of science" and (b) "knowledge about instructional strategies" were considered, even though content-specific PCK was evaluated with a tool. In a summary, Kratz and Schaal (2015) used a multi-perspective questionnaire given in several formats to modify preexisting scales in order to measure both broad and narrow aspects of PCK. Regrettably, it is difficult to generalise the results of modifying one-of-a-kind instruments because of their low validity. Because of this, there is a limit on what instruments may be modified.



Similarly, Pinamang & Cofie (2017) study of pre-service teachers' topic knowledge and pedagogical content knowledge in the context of teaching geometric transformation was conducted using a quantitative methodology. A 12-item version of the Geometric Transformation Achievement Test was used for this method (GTAT). Examinees were asked to demonstrate their familiarity with the topic of geometric transformation in mathematics and their ability to use both their subject matter expertise and their understanding of how to teach it effectively. There were 10 questions on the exam centred around geometric transformation that assessed students' understanding of the material. As well as assessing students' geometric transformation knowledge, questions 11 and 12 assessed their pedagogical content understanding. These two essential questions on pedagogical topic knowledge require that future educators show they can apply their theoretical understanding to real-world scenarios.

Even if all of these ways used to test PCK yield reliable findings, an approach that employs a mix of these various approaches can also be examined. Regardless of the fact that qualitative PCK investigations sometimes employ a small sample size and necessitate a great deal of time for processing. Yet, although questionnaires and tests have been one of the most used approaches in the research of PCK in recent years, no more than six studies have concentrated on the creation of questionnaires to determine PCK in science instructors. Despite the fact that questionnaires and tests have become increasingly popular in the research of PCK, this is still the case (Chan & Hume, 2019). Paper and pencil tests have also been touted as a viable method for establishing PCK. Reasons for this include its reliability, objectivity, and validity, as well as its scalability to bigger samples (Schmelzing et al., 2013). Paper and pencil assessments can be utilised in conjunction with pedagogical artefacts (e.g., Kanter & Konstantopoulos, 2010) or interview (e.g., Roth, Wilson, Taylor, Stuhlsatz, & Hvidsten (2019), Zhou, Wang, & Zhang (2016)

## CONCLUSION

The measurement of PCK as a parameter for determining teacher effectiveness requires a complex and special procedures and can be explored based on classroom observations, through Content Representation (CoRes), through Pedagogical and Professional-experience repertoires (PaP-eRs), structured and semi-structured interviews, stimulated recall interviews, artifacts from teacher's task, concept mapping, teachers reflective journals, questionnaires, tests and lessons observations among others. It have been found out that a paper and pencil evaluation procedures are promising tool to determine PCK, as it is a reliable, objective, and valid method that can be applied to larger samples. However, all these approaches are best used together with others to gather information about PCK from more than one sources for the purpose of triangulation.

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