Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education
Print ISSN: 2814-0885 e-ISSN: 2814-0931
www.fnasjournals.com
Volume 3; Issue 1; November 2021; Page No. 1-10

SENIOR HIGH SCHOOL STUDENT PERCEPTION OF MATHEMATICS TEACHER PEDAGOGICAL CONTENT KNOWLEDGE

[+]Kumi, E. M.
Department of Mathematics and ICT, Adidome Senior High School, Central Tongu District of the Volta Region, GHANA

Wonu, N.
Department of Mathematics/Statistics, Ignatius Ajuru University of Education Port Harcourt, NIGERIA

[+]Corresponding author(email): kumi.enoch@yahoo.com

Abstract
The goal of the study was to find out student perception of teacher Pedagogical Content Knowledge (PCK) at senior high schools in the Central Tongu District of the Volta Region, Ghana. The research design adopted for this study was a mixed-method research design. Four research questions guided this study. A total of 450 Senior High School (SHS) students in Forms Two and Three of the two senior high schools in the Central Tongu District of the Volta Region, in the 2019/2020 academic year participated in the study. The data were gathered via a questionnaire adopted from Jang et al., (2009) and a semi-structured interview. Subject Matter Knowledge (SMK), Instructional Representation and Strategies (IRS), Instructional Objective and Context (IOC), and Knowledge of Student Understanding (KSU) purveyed the PCK. To address the research questions, mean and standard deviation were used. Findings showed that the overall student perception of teacher pedagogical content knowledge for teaching Mathematics was positive. The fact that the mean rating of the students over IRS, IOC and KSU were all less than that of SMK showed that the teachers were more knowledgeable in terms of content than in the delivery of instructions which has more effect on the student achievement in Mathematics. It was recommended among others that Mathematics teachers should pay attention to their SMK because the student perception of teacher SMK could impact their learning of the subject.

Keywords: Perception, Student, Mathematics, Teachers, Pedagogical Knowledge

Introduction

Mathematics cuts across the fundamental human activities, without it man cannot have the basic survival skills. According to Sherrod et al., (2009), the nations in the world which made Mathematics and Science their culture are leading in terms of development and growth, while other nations that have neglected the culture of Mathematics and Science find themselves lagging and have their survival, development and growth threatened. Odili (2019) defined Mathematics as the science of quantity and space. It equips the mind of an individual to develop critical thinking abilities blended with the knowledge and skills of analysis, evaluation, reasoning and communication which provide a conduit to novel discoveries (Su, et al., 2016). It is in this vein that Mathematics is regarded as the bedrock of every economy. Despite the above importance of Mathematics, the performance of students in Mathematics has been poor nationwide over the years. Several studies show that the problem of poor performance in Mathematics is a worldwide canker that has been around for decades and little has been done to change the occurrence (Matthews et al., 2013; Groen et al., 2015). Specifically, studies in Ghana and Nigeria have established that senior secondary school students routinely performed poorly in Mathematics (Enu et al., 2015; Zalmon & Wonu (2017). The poor performance of Ghanaian students reflected in how they performed poorly in the Trends in International Mathematics and Science Study (TIMSS) survey in 2003 and was Ghana placed 45th position in the world (Anamuah-Mensah, et al., 2004; Ferraro, et al., 2006).

Darling-Hammond (2010) and Feiman-Nemser (2012) revealed that teachers have problems with the application of the training they acquired in college into real classroom situations. This makes learners have negative perceptions of the PCK of their teachers and it has an impact on the student results. To get the right information about the level of teacher PCK, there is the need to find out the perception that students have about the PCK of

Cite this article as:
Kumi, E. M., & Wonu,N. (2021). Senior high school student perception of mathematics teacher pedagogical content knowledge. *FNAS Journal of Mathematics and Science Education, 3*(1), 1-10.

their teachers. Student perceptions of teacher pedagogical subject expertise, according to Tuan, et al., (2000), will give trustworthy information about how well students grasp a lesson and how conducive the classroom setting proceedings are to learning. Jaskyte et al., (2009) also pointed out that student rating of teacher PCK provides a true picture of how a teacher is performing in the classroom to enable students to learn. The student perceptions of teacher PCK after a lesson and the reflection of the teachers about the lesson are the important factors for developing teacher PCK. It was suggested that teachers should adopt a way of finding out student perception about their PCK (Jang, et al., 2009)

Wilson et al., (1987, p. 106) defined Pedagogical Content Knowledge (PCK) as "the body of understanding, knowledge, skills, and dispositions that a teacher needs to perform effectively in a given teaching situation". This means that PCK entails all that it takes a teacher to make learners or students understand effectively a given topic or concept. Park and Oliver (2015) viewed PCK as professional knowledge for teachers that are required by the very teacher. All teachers had to have the pedagogical subject knowledge, which was a distinct sort of teacher professional knowledge (Koh, et al., 2010) According to Van Driel et al., (2000), PCK is a specific knowledge for professional teachers because it guides the teachers' actions when dealing with the subject matter in the classroom to help learners to understand the concept of the subject matter very well. PCK is a special body of knowledge that a particular teacher requires to perform successfully in teaching within a complex and varied context of subject matter and classroom situations. Grossman (1990) indicated that teachers could acquire PCK through subject matter knowledge acquisition, teacher educational experiences and teacher observational experiences.

Teacher education courses are frequently arranged so that future teachers obtain subject matter knowledge in content-specific classes and pedagogy in other courses that focus on how to teach subject matter. PCK refers to the knowledge that teachers get over time and via experience on how to teach a certain concept in a specific way that will help students understand it better. Also, the preparation of teachers in subject-specific content can influence teachers' decisions about how to approach the content and sequencing, concepts of what the teachers when to teach a specific subject, and the selection of particular curricula. Hill et al., (2008) and Veal and Kubasko, (2003) also suggest that teachers' value orientations toward subject-matter content may influence textbook content use, pedagogical strategies, and perceptions of students' instructional needs.

Theoretical framework

The theoretical framework of a study is the foundation that supports the theory of the study. The theoretical framework sets up the philosophical basis on which research happens and links the theoretical and practical aspects of the problem under study. It describes the theory that explains how and why that research and connects the research to the existing knowledge. Theoretical frameworks of every study have implications for every decision made in the research process. This study is based on Shulman's Transformative theory of pedagogical content knowledge.

Transformative Theory of Pedagogical Content Knowledge: The idea of pedagogical content anchored on Shulman's Transformative Theory of Pedagogical Content Knowledge (PCK) provides the foundation for PCK. Pedagogical Content Knowledge (PCK) is the general strategies and principles for classroom management and organization that appear to transcend subject matter. It is the knowledge that instructors should have to give effective instruction (Shulman, 1986). Shulman classified this knowledge into three dimensions, viz: Content Knowledge (CK), Curriculum Knowledge (CK), and Pedagogical Content Knowledge (PCK). In 1987, Shulman devised a new model that expanded the components of the type of knowledge that instructors should have to seven dimensions, viz: general pedagogical knowledge, knowledge of learners and their characteristics, knowledge of educational content, knowledge of educational ends, knowledge of content, curriculum knowledge and pedagogical content knowledge.

In an attempt to explain PCK and what constitutes PCK, various models have been proposed to explain what constitutes PCK (Marks, 1990; Shulman, 1986, 1987; Grossman, 1990; Cochran, et al., 1993; Magnusson, et al., 1999). Most of the models of the scholars' conceptualized that PCK is composed of four common components which are knowledge of students' understanding, instructional strategies and representations, curriculum, the teacher's values and beliefs about education. Asiedu–Addo and Yidana, (2000) indicated that the underachievement of students in Mathematics could be a result of lack of PCK of Mathematics teachers therefore teachers need a high level of Pedagogical Content Knowledge (PCK) for teaching Mathematics to improve the performance of students in Mathematics. Mishiwo, et al., (2017), argue that pedagogical content knowledge should be integrated into the teacher training programme to equip teacher trainees with the right

Cite this article as:
Kumi, E. M., & Wonu,N. (2021). Senior high school student perception of mathematics teacher pedagogical content knowledge. *FNAS Journal of Mathematics and Science Education, 3*(1), 1-10.

PCK for teaching. This will help the teachers to perform better during classroom delivery. Many scholars suggest that the PCK of teachers can be developed through an integrative process that is entrenched in classroom practice. The teacher PCK guides the teacher's actions when dealing with a specific subject matter in the classroom which can either promote or hinder learners' level of understanding of a lesson.

All that teachers do in a classroom describes teacher knowledge-on-action as a knowledge plan and enacted through 'reflection-on-action' to deliver topic-specific instruction. The decision making in the classroom may sometimes be instant and requires a dynamic kind of knowledge called knowledge-in-action (Park & Oliver, 2008). The teacher PCK for teaching model was developed by Gess-Newsome, (2015) to display teachers PCK as represented in Figure 1. In this model, the teacher professional knowledge involves content knowledge, assessment knowledge, knowledge of the students, curricular knowledge and pedagogical knowledge. These prepare a teacher for topic-specific professional knowledge which will amplify and filter teachers' beliefs, orientation, prior knowledge and content which also determine teachers' classroom practices. The classroom practices will amplify and filter students' beliefs, prior knowledge, behaviours that bring about students' outcomes. Ball et. al., (2008) found out that knowing a subject matter of Mathematics well may not be sufficient for teaching but how to help students to understand a mathematical concept is needed for effective teaching. Grossman (1990) came out with domains of Mathematical Knowledge for Teaching as shown in Figure 2. Based on this model, the domain of mathematical learning is divided largely into two parts; these are SMK and PCK. The SMK is dimensioned into Horizon Content Knowledge (HCK), Common Content Knowledge (CCK) and Specialized Content Knowledge (SCK) whereas the PCK is also dimensioned into Knowledge of Content and Teaching (KCT), Knowledge of Content and Students (KCS) and Knowledge of Content and Curriculum (KCC). The elements of this model were described as follows by Ball et al., (2008):

CCK stands for "commonly used mathematical knowledge and skill" and refers to mathematical knowledge and skill outside of the classroom. Knowing the algorithm for multiplying two numbers is an example. The SCK is a set of Mathematics skills and knowledge specific to teaching and knowing how the procedure for multiplying two numbers together relates to place value and the distributive property is an example. The HCK is an understanding of how mathematical topics are related across the curriculum in Mathematics, and knowing how the algorithm for multiplying two numbers is related to multiplying two polynomials is an example. KCS is a type of knowledge that blends the knowledge of students with knowledge of Mathematics. Teachers must predict what students would believe and what will be puzzling to them. Knowing that while multiplying two numbers, learners may make the mistake of not moving the terms to be added appropriately is an example. KCT combines knowledge of teaching and about the subject, Mathematics. Knowing the instructional model to adopt in the Mathematics classroom so that when students are multiplying two numbers they will learn how and why they should shift the term to be added is an example. The KCC has to do with a variety of programmes developed to teach specific subjects and topics respecting the level, multifarious teaching aids provided for the programmes and the class of features that purvey both indications and contraindications for the adoption of specific curriculum or teaching aid in specific situations. The knowledge of the availability of teaching aids for teaching and learning of two numbers multiplication, the method these teaching aids take and how efficacious the materials are is an example.

According to Ampadu (2012), student perception about teacher PCK affects learning outcomes in Mathematics positively or negatively. If students hold a positive perception about their Mathematics teacher PCK, they are motivated during Mathematics lessons so they study hard to perform well in Mathematics than those students that hold negative perceptions about their Mathematics teacher PCK. Peterson, et al., (2000) reveal that the perceptions learners have about their teacher's PCK may be different from outside observers perception of teacher's PCK. The authors continue that it is, therefore, necessary to require the learners of a particular subject to evaluate the kind of perceptions they have about their teacher than to depend on the outside observers' perceptions to judge teacher PCK.

Waxman, et al., (2004) indicated that students' view of their teacher PCK can help researchers, teachers, and other stakeholders understand and comprehend the perceived instructional and contextual influences on student learning processes and achievement. Tuan et al., (2000) reveal that students expect teachers to have strong content knowledge and use effective instructional methods. Based on these expectations that students will be able to provide their opinions for the researchers and other stakeholders as a reflection to discern whether teachers' PCK was good or bad. Although students' perceptions may not be the same as teachers' self-perception, the students' perceptions provide a relatively objective account and alternative view of teachers' practices in the classroom. To acquire a true picture of what happens in the classroom and how teachers

Cite this article as:
Kumi, E. M., & Wonu,N. (2021). Senior high school student perception of mathematics teacher pedagogical content knowledge. *FNAS Journal of Mathematics and Science Education, 3*(1), 1-10.

influence students' lives, which is reflected in their exam results, one must look at it from the perspective of the students, not from the perspective of outside observers.

According to De Jong and Westerhof (2001), making students evaluate their teachers' teaching behaviours during and after lessons makes it possible to get a good picture of teachers' teaching behaviour built from the perspective of the students. The perception of the students regarding the behaviour of their teachers predicts the learning outcomes of the students than observations that are external or subjective perceptions of the teachers regarding their behaviour (Maulana et al., 2015). Van de Grift (2007) and Mateo (2000) questioned whether very young children are capable of making the objective, consistent appraisals of their teachers' behaviour whereas Den Brok et al, (2004) opined that secondary students, on the other hand, were able to provide assessments of teacher behaviour that were sufficiently stable, reliable, valid, and predictive of instructors' teaching behaviour in and out of the classroom. Bransford (2000) discovered that in the classroom, several factors can interact to hinder teacher-pupil interactions, either separately or in combination. According to the author, the ages of teachers and students are frequently rather disparate. Teachers and students have vastly varied social and educational experiences, and they often come from quite different social backgrounds. These differences may produce situations in which teachers and some students may have little in common of experiences and understandings which will make some of the students have the kind of perceptions about the teachers which may or may not depict the real performance of the teachers. What seems conducive and favourable attitudes to teachers in terms of school practices and handling of the subject matter may not be conducive and favourable to learners, therefore marking the students form the perceptions based on their views (Reece & Walker, 1997; Cameron-Jones & Morrison, 2002).

In terms of the ability of the students to make reliable judgments about their teachers' classroom effectiveness, it is advantageous to allow students to rate their teachers based on their thoughts and emotions about their teachers' classroom effectiveness as it relates to their learning effectiveness because teachers' success is best measured by their students' achievement (Cameron-Jones & Morrison, 2002). According to Petty (2004), a student's self-concept about his instructor and the subject(s) the teacher teaches is influenced by his opinion of the teacher. This view eventually has an impact on the pupils' overall academic achievement. Furthermore, students' perception of their teachers eventually leads to the development of either a negative or positive self-concept in the teacher's subject by such students. This may result in the pupils being high achievers or low performers academically. As a result, the types of roles or attitudes that a teacher adopts have a significant impact on students' impressions of the instructor, and the way a specific student is considered by his peers can sometimes be based on the teacher's behaviour with the student. Students may retreat to themselves most of the time due to their perceptions of their teachers, according to research, and then transfer this withdrawal attitude to the teachers' subjects in the classroom (Wattenberg & Clifford, 2004).

Problem Specification

The Mathematics underachievement among SHS students in Central Tongu District has been a source of concern for many Mathematics educators, parents, students, and other stakeholders in the district. Student poor perception of teacher PCK could have an effect on the participation of the students during the lesson and can also affect the teacher self-efficacy beliefs in the classroom which will result in poor performance in Mathematics. Studies have confirmed that the perception of the students regarding the pedagogical content knowledge of the teachers impacts the understanding of lessons taught (Tuan, et al, 2000; Jang, et al., 2009). In line with the foregoing, this study explores the SHS student perception of Mathematics teacher PCK in the Central Tongu District of the Volta Region, Ghana.

Purpose of the study

The purpose of this study is to examine the Senior High School student perception of Mathematics teacher PCK in the Central Tongu District of the Volta Region, Ghana. Specifically, the objectives of the study are to:

1. determine the student perception of Mathematics teacher SMK
2. find out the student perception of Mathematics teacher IRS
3. explore the student perception of Mathematics teacher IOC
4. determine the student perception of Mathematics teacher KSU

Research questions

The study was guided by the following research questions:

1. How might we describe student perception of Mathematics teacher SMK?
2. What is the student perception of Mathematics teacher IRS?

Cite this article as:
Kumi, E. M., & Wonu,N. (2021). Senior high school student perception of mathematics teacher pedagogical content knowledge. *FNAS Journal of Mathematics and Science Education, 3*(1), 1-10.

3. How might we describe the student perception of Mathematics teacher IOC?
4. What is the SHS student perception of Mathematics teacher KSU?

Materials and Methods

Design: To carry out the study effectively the study adopted the mixed-method research design. This design was adopted for this study because they involved the collection of data from a large sample size to answer the research questions describe or reveal the current status of student perception about Mathematics teacher pedagogical content knowledge. It also involves the use of interviews. The mixed-method approach is the scientific method of research that blends both quantitative and qualitative research methods in one study (McMillan & Schumacher, 2010; Creswell, & Creswell, 2017).

Participants: The population for this study consisted of all SHS forms two and three SHS students in Central Tongu District in the Volta Region of Ghana. There are two Senior High Schools in the Central Tongu District. The two senior high schools had a total of 1749 students who are in forms two and three with thirty (30) Mathematics teachers. A total of 450 students took part in the study. The random sampling technique was used to compose the sample for the study.

Instrumentation: A questionnaire and a semi-structured interview guide were employed as research instruments to gather data for the study. The instrument used for data collection was titled Student Perception of Teacher Pedagogical Content Knowledge (SPTPCK). The study adopted a questionnaire developed by Jang et al., (2009). The questionnaire consisted of 28 items which were subdivided into 4 categories which are: SMK, IRS, IOC and KSU. The questionnaire was used to collect quantitative data on the perception of the students regarding the PCK of their teachers in the teaching of Mathematics. The interview was used to collect data on some of the selected responses during the study for confirmation of the results obtained using the quantitative data. Bryman and Bell (2007) noted that every instrument has its design and the particular purpose it is used for.

Data Analysis: Mean and Standard Deviation were used for answering the research questions. The criterion mean-cut-off score of 3.0 was used for decision making. The interview data were transcribed, analysed and summarised using percentages to obtain the overall opinion of the students regarding the PCK of teachers in the teaching of Mathematics. This was done to validate the result obtained using the quantitative data obtained with the questionnaire.

Results

The research questions sought to examine student perception of teacher PCK for teaching SHS Mathematics. To achieve the objectives, a questionnaire and interview guides were used to collect data from the students. A semi-structured interview guide was used by the researchers to interview the students to get the confirmation of the result from the questionnaire. The results in Tables 1 to 4 showed the total mean perceptions of the students over various items and Table 5 shows the overall mean perception of the students regarding the four categories of Student perception of teacher PCK.

Table 1: Summary of mean rating on student perception of teacher SMK

					95% CI	
SN	**A: Subject Matter Knowledge (SMK)**	**Mean**	**SD**	**SEM**	**LB**	**UB**
1	My teacher knows the content he/she is teaching.	4.71	0.66	0.04	4.64	4.79
2	My teacher explains clearly the content of the subject.	4.44	0.87	0.05	4.34	4.54
3	My teacher knows how theories or principles of the subject have been developed.	4.48	0.82	0.05	4.39	4.57
4	My teacher selects the appropriate content for students.	4.43	1.01	0.06	4.32	4.54
5	My teacher knows the answers to questions that we ask about the subject.	4.53	0.90	0.05	4.43	4.64
6	My teacher explains the impact of subject matter on society.	4.14	1.16	0.07	4.01	4.27
7	My teacher knows the whole structure and direction of this course.	4.56	0.81	0.05	4.47	4.66
	Grand mean	**4.47**	**0.62**	**0.04**	**4.40**	**4.54**

Table 1 shows the summary of the mean rating on student perception of teacher pedagogical content knowledge for teaching SHS Mathematics. It shows that the grand mean rating of the students over their teacher pedagogical content knowledge was 4.47, SD=0.67. The result further shows that respondents strongly indicated that their teacher knows the content they teach (M=4.71, SD=.66). This was followed by the fact that their

Cite this article as:
Kumi, E. M., & Wonu,N. (2021). Senior high school student perception of mathematics teacher pedagogical content knowledge. *FNAS Journal of Mathematics and Science Education, 3*(1), 1-10.

teachers know the whole structure and direction of this course (M=4.56, SD=0.81), their teachers know the answers to questions that we ask about the subject (M=4.53, SD=1.01) and their teachers know how theories or principles of the subject have been developed (M=4.48, SD=0.82) among others.

Table 2: Summary of mean rating on student perception of teacher IRS

					95% CI	
	B: Instructional Representation & Strategies (IRS)	**Mean**	**SD**	**SEM**	**LB**	**UB**
8	My teacher uses appropriate examples to explain concepts related to the subject matter.	4.57	0.91	0.05	4.47	4.67
9	My teacher uses familiar analogies to explain concepts of subject matter.	4.38	0.99	0.06	4.26	4.49
10	My teacher's teaching methods keep my interest in this subject.	4.35	1.03	0.06	4.23	4.47
11	My teacher provides opportunities for me to express my views during class.	4.53	0.99	0.06	4.42	4.65
12	My teacher uses demonstrations in explaining the main concept.	4.33	1.07	0.06	4.20	4.45
13	My teacher uses a variety of teaching approaches to transform subject matter into comprehensible knowledge.	4.23	1.10	0.06	4.10	4.36
14	My teacher uses multimedia or technology to express the concept of the subject.	3.17	1.63	0.09	2.99	3.35
	Grand mean	**4.22**	**0.77**	**0.04**	**4.14**	**4.31**

The result from Table 2 shows the summary of mean rating on student perception of teacher IRS. It shows that the grand mean rating of the respondents over teacher instructional representation and strategies was 4.22, SD=0.77. The result shows that the students strongly indicated that their teachers use appropriate examples to explain concepts related to the subject matter (M=4.57, SD=0.91). This was followed by the fact that their teachers provide opportunities for them to express their views during class (M=4.53, SD=0.99), their teachers use familiar analogies to explain concepts of subject matter (M=4.38, SD=0.99) and their teachers teaching methods aid to keep their interest in the subject(M=4.35, SD=1.03) among others.

Table 3: Summary of mean rating on student perception of teacher IOC

					95% CI	
	C: Instructional Objective & Context (IOC)	**Mean**	**SD**	**SEM**	**LB**	**UB**
15	My teacher makes me clearly understand the objectives of this course.	4.26	1.08	0.06	4.14	4.38
16	My teacher provides an appropriate interaction or a good atmosphere.	4.26	1.12	0.06	4.13	4.38
17	My teacher pays attention to students' reactions during class and adjusts his/her teaching attitude.	4.41	1.10	0.06	4.29	4.54
18	My teacher creates a classroom circumstance to promote my interest in learning.	4.21	1.19	0.07	4.08	4.35
19	My teacher prepares some additional teaching materials.	3.76	1.41	0.08	3.60	3.92
20	My teacher copes with our classroom context appropriately.	4.20	1.11	0.06	4.07	4.32
21	My teacher's belief or value in teaching is active and aggres-sive	4.19	1.22	0.07	4.05	4.33
	Grand mean	**4.19**	**0.84**	**0.05**	**4.09**	**4.28**

The result from Table 3 shows the summary of mean rating on student perception about the instructional objective and context ability of their teachers. It shows that the grand mean rating of the students over teachers' instructional objective and context was 3.19, SD=0.84. It shows that the students strongly indicated that their teachers pay attention to students' reactions during class and adjust their teaching attitude(M=4.41, SD=1.10), their teachers make them clearly understand the objectives of the course(M=4.26, SD=1,08), their teachers provide an appropriate interaction or a good atmosphere(M=4.26, SD=1.12), their teachers create a classroom circumstance to promote their interest in learning(M=4.21, SD=1.19) and their teachers cope with their classroom context appropriately(M=4.20, SD=1.11) among others.

Cite this article as:
Kumi, E. M., & Wonu,N. (2021). Senior high school student perception of mathematics teacher pedagogical content knowledge. *FNAS Journal of Mathematics and Science Education, 3*(1), 1-10.

Table 4: Summary of mean rating on student perception of teacher KSU

	D: Knowledge of Students' Understanding (KSU)	Mean	SD	SEM	95% CI LB	UB
22	My teacher realizes students' prior knowledge before class.	4.21	1.09	0.06	4.09	4.34
23	My teacher knows students' learning difficulties of the subject before class.	4.22	1.12	0.06	4.09	4.35
24	My teacher's questions evaluate my understanding of a topic.	4.30	1.17	0.07	4.17	4.43
25	My teacher's assessment methods evaluate my understanding of the subject.	4.27	1.11	0.06	4.15	4.40
26	My teacher uses different approaches (questions, discussion, etc.) to find out whether I understand.	4.44	1.03	0.06	4.32	4.55
27	My teacher's assignments facilitate my understanding of the subject.	4.26	1.17	0.07	4.13	4.40
28	My teacher's tests help me realize the learning situation.	4.46	1.01	0.06	4.35	4.58
	Grand mean	**4.31**	**0.86**	**0.05**	**4.21**	**4.41**

The result from Table 4 shows the summary of mean rating on student perception about teacher knowledge of student understanding. It shows that the grand mean rating of the students over teachers' knowledge of students' understanding was 4.31, SD=0.86. The result shows that the students strongly indicated that their teachers' tests help them realize the learning situation (M=4.46, SD=1.01), this was followed by the fact that their teachers use different approaches (questions, discussion, etc.) to find out whether they understand(M=4.44, SD=1.03), their teacher's questions evaluate their understanding of a topic(M=4.30, SD=1.17), their teachers' assessment methods evaluate their understanding of the subject (M=4.27, SD=1.11) and their teachers' assignments facilitate their understanding of the subject (M=4.26, SD=1.17) among others.

Table 5 Summary of the overall mean ratings on student perception about teacher PCK

SN	Sub-variables	95% CI Mean	SD
1	Subject Matter Knowledge (SMK)	4.46	0.62
2	Instructional Representation & Strategies (IRS)	4.21	0.75
3	Instructional Objective & Context (IOC)	4.19	0.81
4	Knowledge of Students' Understanding (KSU)	4.32	0.83
	Overall mean	**4.30**	**0.75**

The result from Table 5 shows the summary of total means on student perception about teacher pedagogical content knowledge for teaching SHS Mathematics with the overall mean of the general perception of their teachers' PCK (4.30, SD=0.75). The overall result showed that the student perception of teacher PCK was good and positive. The result from the sub-variables of PCK in Table 5 shows that the SMK, IRS, IOC and KSU were all rated above the criterion mean of 3.0, indicating that the PCK was adequate. It is also worthy of note that among the dimensions of PCK investigated, SMK had the highest mean rating (M=4.46, SD=0.62), this was followed by KSU (M=4.32, SD=0.83) and the least was IOC(M=4.19, SD=0.81). The fact that the mean rating of the students over IRS, IOC and KSU were all less than that of SMK showed that the teachers were more knowledgeable in terms of content than the delivery of instructions which has more effects on the student achievement in Mathematics. The teacher low level of IRS could lead to the low achievement of IOC by the teachers which affect student performance.

Interview results: In a nutshell, about 89% of the students interviewed on their perceptions of teacher PCK corroborated their perception about teacher PCK using a questionnaire. It shows that the perception of students regarding the PCK of their teachers was good and positive.

Discussion of Findings

The general student perception about teacher pedagogical content knowledge for teaching SHS Mathematics purveyed by SMK, IRS, IOC and KSU were respectively rated above the criterion mean score of 3.0 on a 5-point rating system which means the general perceptions of the students about teacher PCK was good and positive. The result from Table 5 showed that the SMK, IRS, IOC and KSU were all rated above the criterion mean score of 3.0, indicating that the teacher PCK was adequate. It is also worthy of note that among the

Cite this article as:
Kumi, E. M., & Wonu,N. (2021). Senior high school student perception of mathematics teacher pedagogical content knowledge. *FNAS Journal of Mathematics and Science Education, 3*(1), 1-10.

variables of PCK investigated, SMK had the highest rating and this was followed by KSU and the least was IOC. The fact that the mean rating of the students over IRS, IOC and KSU were all less than that of SMK showed that the students perceived their teachers were more knowledgeable in terms of content than the delivery of instructions which has more effect on the student achievement in Mathematics. Also, the teachers' low level of IRS led to the teachers' low achievement of IOC which may affect student learning outcomes. In general, the student perception of Mathematics teacher PCK was positive. The findings of this study are in agreement with earlier findings of which established that teachers who have high self-efficacy can be effective in PCK thereby creating a positive perception in the mind of students (Podell & Soodak 1993; Peterson et al., 2000; Ball et al*.,* 2008; Ampadu 2012).

Conclusion

The general perception of students about their Mathematics teacher PCK was good and positive. This means that the student perceptions about teacher teaching ability, thus their pedagogical content knowledge was encouraging. Even though the general perceptions of students about teacher pedagogical content knowledge was positive, further study is required to explore whether the teacher sound PCK translates into an excellent performance amongst students in Mathematics. Therefore, the study concludes that the student positive perception of teacher pedagogical content knowledge may not be enough motivation for better performance in Mathematics.

Recommendations

Based on the findings of the study, it was recommended that:

1. Mathematics teachers should pay attention to their SMK because the student perception of teacher SMK could impact on learning of the subject by the students
2. Mathematics teachers should take seriously their instructional representations and strategies adopted in the classroom.
3. The teachers of Mathematics should develop sound instructional objectives and context for better student understanding
4. Mathematics teachers should try to understand the knowledge of their students regarding any concept taught in the class.

References

Ampadu, E. (2012). Students' Perceptions of their Teachers' Teaching of Mathematics: The Case of Ghana. *International Online Journal of Educational Sciences, 2012, 4*(2), *351-358.*

Anamuah-Mensah, J., Mereku, D. K. & Asabere-Ameyaw, A. (2004). *Ghanaian junior secondary school students' achievement in Mathematics and science: Results from Ghana's participation in the 2003 Trends in International Mathematics and Science Study*. Accra: Ministry of Education Youth and Sports.

Asiedu-Addo S. K. & Yidana I. (2000). Mathematics teachers' knowledge of the subject content and methodology. *Journal for the Mathematical Association of Ghana.*12, 65-71.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special. *Journal of teacher education?*, *59*(5), 389-407.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn* (Vol. 11). Washington, DC: National academy press.

Bryman, A. & Bell, E. (2007). *Business research methods*. Oxford University Press, USA.

Cameron-Jones, M. & Morrison, A. (2002). *Teachers' assessments of their pupils*. Unpublished Report, Department of Education, University of Dundee.

Cochran, K. F., DeRuiter, J. A., & King, R. A. (1993). Pedagogical content knowing: An integrative model for teacher preparation. *Journal of Teacher Education*, *44*(4), 263-272.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approach*. Sage publications.

Darling-Hammond, L. (2010). Recruiting and retaining teachers: Turning around the race to the bottom in high-need schools. *Journal of curriculum and instruction*, *4*(1), 16-32.

De Jong, R., & Westerhof, K. J. (2001). The quality of student ratings of teacher behaviour. *Learning Environments Research*, *4*(1), 51-85.. *doi: 10.1023/A:1011402608575*

Den Brok, P., Brekelmans, M., & Wubbels, T. (2004). Interpersonal teacher behaviour and student outcomes. *School effectiveness and school improvement*, *15*(3-4), 407-442. *doi: 10.1080/09243450512331383262*

Enu, J., Agyeman, O. J., & Nkum, D. (2015). Factors influencing students' mathematics performance in some selected colleges of education in Ghana. *International Journal of Education Learning and Development,3*(3), 68-74

Eshun, B. A. (1999). The pattern of mathematical achievement of secondary school students in Ghana. *Journal of Science and Mathematics Education*, *2*(1), 22-33.

Feiman-Nemser, S. (2012). Beyond solo teaching. *Educational Leadership, 69*, 10- 6

Ferraro, D., & Van de Kerckhove, W. (2006). Trends in International Mathematics and Science Study (TIMSS) 2003. Nonresponse Bias Analysis. Technical Report. NCES 2007-044. *National Center for Education Statistics*.

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK: Results of the thinking from the PCK Summit. In *Re-examining pedagogical content knowledge in science education* (pp. 38-52). Routledge.

Groen, L., Coupland, M., Langtry, T., Memar, J., Moore, B., & Stanley, J. (2015). The Mathematics problem and mastery learning for first-year, undergraduate STEM students. *International Journal of Learning, Teaching and Educational Research*, *11*(1).*141–160.*

Grossman, P. L. (1990). *The making of a teacher: Teacher knowledge and teacher education*. Teachers College Press, Teachers College, Columbia University.

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education*, *39*(4), 372-400.

Jang, S. J., Guan, S. Y., & Hsieh, H. F. (2009). Developing an instrument for assessing college students' perceptions of teachers' pedagogical content knowledge. *Procedia-Social and Behavioral Sciences*, *1*(1), 596-606.

Jaskyte, K., Taylor, H., & Smariga, R. (2009). Student and faculty perceptions of innovative teaching. *Creativity Research Journal*, *21*(1), 111-116.

Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2010). Examining the technological pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. *Journal of Computer Assisted Learning*, *26*(6), 563-573.

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In *Examining pedagogical content knowledge* (pp. 95-132). Springer, Dordrecht.

Marks, R. (1990). Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of teacher education*, *41*(3), 3-11.

Mateo, J. (2000). La evaluación del profesorado y la gestión de la calidad de la educación. Hacia un modelo comprensivo de evaluación sistemática de la docencia. *Revista de investigación educativa*, *18*(1), 7-34.

Matthews, K. E., Hodgson, Y., & Varsavsky, C. (2013). Factors influencing students' perceptions of their quantitative skills. *International Journal of Mathematical Education in Science and Technology*, *44*(6), 782-795.

Maulana, R., Helms-Lorenz, M., & van de Grift, W. (2015). Development and evaluation of a questionnaire measuring pre-service teachers' teaching behaviour: A Rasch modelling approach. *School Effectiveness and School Improvement*, *26*(2), 169-194.

McMillan, J. H., & Schumacher, S. (2010). Research in Education: Evidence-Based Inquiry, MyEducationLab Series. *Pearson*.

Mishiwo. M, Sedega, B. C., Anane, E., & Awuitor, G. K. (2017). Pre-service teachers' use of pedagogical content knowledge in teaching and learning Mathematics at basic seven in Akatsi District, Ghana. *British Journal of Education 5*(2), 65-76.

Odili, G.A. (2019).*The Philosophy and History of Mathematics*. Mary Godwin Press.

Park, S., & Oliver, J. S. (2008). Revisiting the conceptualisation of pedagogical content knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research in Science Education*, *38*(3), 261-284.

Park, S., & Suh, J. K. (2015). From portraying toward assessing PCK: Drivers, dilemmas, and directions for future research. In *Re-examining pedagogical content knowledge in science education* (pp. 114-129). Routledge.

Peterson, K. D., Wahlquist, C., & Bone, K. (2000). Student surveys for school teacher evaluation. *Journal of Personnel Evaluation in Education*, *14*(2), 135-153.

Petty, G. (2004). *Teaching today: A practical guide*. Nelson Thornes.

Podell, D. M., & Soodak, L. C. (1993). Teacher efficacy and bias in special education referrals. *The Journal of educational research*, *86*(4), 247-253.

Reece, I., & Walker, S. (1997). *A practical guide to teaching, training and learning*. Sunderland: Business Education Publishers.

Sherrod, S. E., Dwyer, J., & Narayan, R. (2009). Developing science and math integrated activities for middle school students. *International Journal of Mathematical Education in Science and Technology*, *40*(2), 247-257.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher*, *15*(2), 4-14.

Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform. *Educational Review, 57(1), 1-22.*

Su, H.F., Ricci, F.A., & Mnatsakanian, M. (2016). Mathematical teaching strategies: Pathways to critical thinking and metacognition. Journal of Research in Education and Science (IJRES), 2 (1), 190-200

Tuan, H. L., Chang, H. P., Wang, K. H., & Treagust, D. F. (2000). The development of an instrument for assessing students' perceptions of teachers' knowledge. *International Journal of Science Education*, *22*(4), 385-398.

Van de Grift, W. (2007). Quality of teaching in four European countries: A review of the literature and application of an assessment instrument. *Educational Research*, *49*(2), 127-152.. *doi: 10.1080/00131880701369651*

Van Driel, J.H, De Jong, N, &Verloop, N. (2000). The development of pre-service Chemistry teachers' pedagogical content knowledge. *Science Education, 86,* 572-590.

Veal, W. R., & Kubasko Jr, D. S. (2003). Biology and Geology Teachers' Domain-Specific Pedagogical Content Knowledge of Evolution. *Journal of curriculum and supervision*, *18*(4), 334-52.

Wattenberg, W.W. & Clifford, C. (2004). Relationship of self-concept to beginning achievement in reading. *Child Development*, *35, 461-467.*

Waxman, H. C., Padrón, Y. N., & Gray, J. P. (Eds.). (2004). *Educational resiliency: Student, teacher, and school perspectives*. Greenwich, CT: Information Age.

Wilson, S., Shulman, L., & Richert, A. (1987). 150 different ways of knowing: Representations of knowledge in teaching. In J. Calderhead (Ed.), *Exploring teachers' thinking* (pp. 104-124). Cassell

Zalmon, I.G.&Wonu N. (2017). Comparative analysis of students mathematics achievement in West African Senior Secondary School Certificate examination in Nigeria. *European Journal of Research and Reflection in Education Science*, 5(1), 25-31

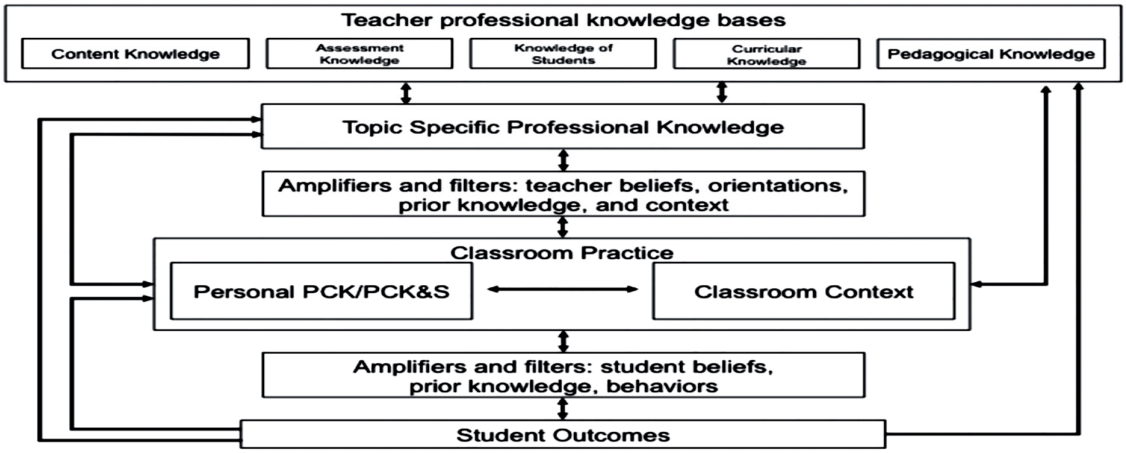

Figure 1: Adopted from the 'PCK Summit Consensus Model' (Gess-Newsome, 2015).

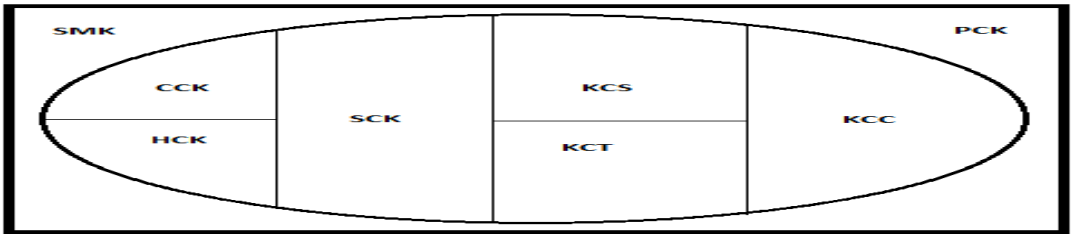

Figure 2: Mathematical Knowledge for Teaching (Grossman, 1990)

Cite this article as:
Kumi, E. M., & Wonu,N. (2021). Senior high school student perception of mathematics teacher pedagogical content knowledge. *FNAS Journal of Mathematics and Science Education, 3*(1), 1-10.