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Teachers' Methods, Content Knowledge and Learners' Attitudes Towards Learning Physics in Uganda

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Abstract

Secondary school learners have negative attitudes towards physics. This study investigated the relationship between learners' attitudes towards physics and teachers' methods and content in teaching Physics. A cross-sectional research design deploying a mixed method was used with 19 teachers and 327 learners. A questionnaire for learners and an interview guide for teachers were utilised to collect data. While thematic analysis was used for the qualitative data, descriptive statistics, Pearson correlation and regression analysis were used for quantitative data. Three themes emerged from the qualitative data: excitement, engagement, and demotivation. The quantitative results show that teachers' PK and PCK enhanced learners' attitudes towards physics. A regression analysis revealed that PK and PCK accounted for most variations, while CK had the least, suggesting a clear importance of pedagogy in influencing learners' attitudes towards physics. This study recommends designing modules in PK and PCK with real-life challenges to enhance learners' attitudes toward physics.

How to Cite

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INTRODUCTION

Teachers' knowledge affects learners' scientific understanding of physics concepts, which promotes societal development (OECD, 2020). Despite the importance of physics in society, many learners find it challenging (Irele et al., 2022), which results in low performance. For instance, in the United Kingdom (UK), Turkey, and the United States of America (USA), learners' physics performance is poorer than in chemistry and biology (Erdemir, 2009). Similarly, the Uganda National Examinations Board results show that learners have consistently performed poorly in physics for the past ten years (Lacambra, 2016). To address the poor performance, many innovations like recruiting more physics teachers, re-skilling teachers, providing physics textbooks, and building more physics laboratories and stocking them, have been employed (Dilshad et al., 2019), but no change in learners' performance has ensued (Namatende, 2017).

The persistent learners' poor performance could be attributed to teachers' knowledge (Gess-Newsome et al., 2019), teaching for exams where learners memorise content with no experiential learning (Babalola et al., 2020), and inadequate teachers' pedagogical practices (Kwarikunda et al., 2020). In Fort Portal City, learners perform poorly in physics (Lacambra, 2016). Also, traits could affect their performance because there is a strong correlation between attitudes and learning (Martinko & Vorkapi, 2017). According to Nandugwa (2018), nothing is known about teachers' content and methods, and the learners' attitudes towards physics learning in Fort Portal City in Uganda. Thus, there is no study where learners report on teachers' Pedagogical Content (PK), Content Knowledge (CK) and Pedagogical Content Knowledge (PCK) while teachers report on the influence of their pedagogy and content on learners' attitudes towards learning physics. This is a knowledge gap this study seeks to contribute to by establishing the relationship between learners' attitudes towards physics and teachers' content and methods in Uganda.

Problem Statement

Physics provides the basis for many academic disciplines and professions (Noah, 2019). Globally, secondary school learners perform poorly in Physics, including in Sub-Saharan African nations like Uganda (Kisaka, 2016). For learners to picture the content and become more motivated to study it, teachers' PCK plays a vital role (Veloos & Khalid, 2015). Despite innovations made in the country to improve, the final physics examination has remained the same (Lacambra, 2016). Learner performance is a result of teacher-learner relationships in the classroom environment. Therefore, the study aimed to ascertain how the teachers' pedagogical, content, and pedagogical content knowledge related to the learners' attitudes toward learning physics.

Theoretical Perspective

The PCK approach developed by Gudmundsdottir and Shulman (1987) was applied in this study. It emphasizes how teachers' PK, CK, and PCK influence learners' attitudes towards learning, as shown in Figure 1.

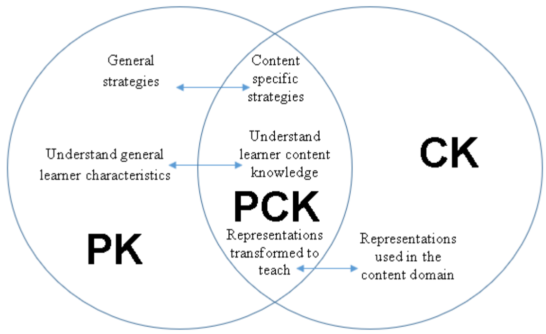

Figure 1. Teachers' knowledge bases adopted from Graham (2012)

The theory deals with PCK, showing how teachers present their knowledge of the subject and their awareness of the learners' challenges to understanding a particular concept (Loewenberg et al., 2008). Thus, one of the important factors influencing learners' understanding and performance in physics is the teachers' PCK (Azam, 2020). This theoretical framework fits the study as it illustrates how teachers' PK, CK and PCK support the skills development of learners in physics and, hence, impact performance.

Purpose and Research Questions

The purpose of the study was to investigate the relationship between learners' attitudes and teachers' Pedagogical Knowledge (PK), Content Knowledge (CK), and (PCK) in Uganda. Hence, the following questions were asked: 1) What is the relationship between teachers' pedagogical knowledge and learners' attitudes towards learning physics?; 2) What is the relationship between teachers' content knowledge and learners' attitudes towards physics?; 3) Is there a connection between teachers' pedagogical content knowledge and learners' attitudes towards learning physics?

Hypotheses

The study's hypotheses were as follows:

H_1. A significant link exists between learners' attitudes toward learning physics and teachers' PK.

H_2. A considerable correlation exists between teachers' CK and learners' attitudes toward learning physics.

H_3. A correlating relationship exists between learners' attitudes toward learning physics and teachers' PCK.

LITERATURE REVIEW

Several studies have investigated how pre-service and in-service teachers' classroom instruction methods are affected by their pedagogical knowledge (PK), content knowledge (CK), and pedagogical content knowledge (PCK).

Pre-service Teachers' Knowledge

Schiering et al. (2022) conducted a study in Germany to ascertain pre-service physics teachers' PCK knowledge levels and how teacher education might help transitions towards higher proficiency. The study showed that low levels of competence were associated with recalling general knowledge, while high levels involved the application of subject-specific strategies to enhance teaching and comprehension. Additionally, their logistic regression models indicated that CK improved the PCK of pre-service physics teachers' proficiency (Schiering et al., 2022), as these enable learners to acquire basic and integrated science skills (Kibirige et al., 2022).

In-service Teachers' Knowledge

Bas and Senturk (2018) researched the views of Turkish in-service teachers working in public schools on their awareness of technological pedagogical content. They discovered that in-service teachers' perceptions of their mastery of technology pedagogical material were influenced by their gender, education degree, teaching experience, and participation in educational computer and internet use seminars. The results also revealed that the in-service teachers' perceptions of their technological pedagogical content understanding were modest. Prasart (2011) investigated how in-service science teachers responded to the PCK paradigm. According to his research, in-service teachers can modify their PCK beliefs by implementing instructional practices and incorporating content knowledge into the classroom based on their motivation to work as teachers.

Sabah *et al.* (2016) also conducted a study to assess how in-service teachers perceived their CK, PK, and PCK. Their findings did not reveal any appreciable differences in the teachers› CK. A difference was seen between PK and PCK. They recommended that teacher education programs align with pre-service teacher education models intended to enhance CK, PK, and PCK. More specifically, PCK in science and math instruction was studied by Elvira et al. (2023), and their findings show different degrees of progressive PCK development among pre-service and in-service teachers. Thus, teachers' PCK levels can impact how learners feel about learning physics.

Learner Attitudes towards Learning Physics

In Malaysia, Norezan et al. (2019) studied learners' attitudes towards learning physics and the challenges encountered in understanding force and motion among form four learners. Most of the learners had positive attitudes toward learning physics. However, despite doing identical studies in Ghana and Nigeria, Mabee et al. (2021) and Monica (2021) found that most respondents had a negative attitude towards learning physics. As a result, it was recommended that physics teachers employ creative and engaging techniques to make the subject fascinating and appealing. Learners in Ugandan secondary schools lack the motivation and enthusiasm to learn physics (Kwarikunda et al., 2020). It may help to explain why teachers need to raise learner motivation if there is a correlation between learners' interest in physics and their motivation to learn the subject. The relationship between teachers' CK, PK, and PCK and pupils' attitudes have not been studied in Fort Portal City, Uganda.

METHODS

Research Approach and Design

Approach

The study used a mixed-methods approach, where the qualitative Approach gave a subjective, in-depth understanding of teachers' experiences with PK, CK, and PCK, and the quantitative Approach gave an objective analysis to allow for the generalization of the findings (Creswell & Plano, 2017).

Design

This study used a cross-sectional survey design (Collins et al., 2023) because it allows for the simultaneous comparison of numerous variables.

Data of interest were gathered from a population at a certain moment (Creswell & Plano, 2017).

Quantitative Instrument

Using a self-administered questionnaire (SAQ), data from the learners were gathered for the quantitative investigation. The SAQ's three sections included respondents' demographic data (Section A), teachers' knowledge (PK, CK, and PCK) (Section B), and learners' attitudes towards learning physics (Section C). The first author created SAQ 5 Likert scale questions, including 11 questions on assessing learners' attitudes toward learning physics, 15 on teachers' PK, eight on teachers' CK, and 14 on teachers' PCK. The answers ranged from 1 (Strongly Disagree (SD)), 2 (Disagree (D)), 3 (Not Sure (NS)), 4 (Agree (A)), and 5 (Strongly Agree (SA)).

Eight raters evaluated the validity of the questionnaire. The rating yielded a CVI score of 0.78. As it was over 0.7, the minimum allowable value taken into consideration, this number shows that the instrument was valid (Mohajan, 2017). Twenty participants who were not involved in the research study procedure participated in a pilot study that was done to establish the instrument's reliability. A Cronbach Alpha value of 0.852, which is within the acceptable range for the study, was obtained (Nawi *et al.,* 2020).

Normality Test

The data were subjected to Kolmogorov-Smirnov test to determine normality (Table 1). The estimated results of learners' attitudes toward learning physics and teachers' knowledge gave a value of Asym. p - value > .05. Therefore, it implies that the independent and dependent variables are normally distributed.

Table 1. Normality test.

Variables	Tests of Normality	
	Asym. P – value	Explanation
Learners' attitudes towards learning Physics	.821	Normal
Pedagogical content knowledge of teachers	.482	
Content knowledge of teachers	.570	
Pedagogical knowledge of teachers	.619	

Test for Homogeneity

A homogeneity test was conducted to ascertain the data's homogeneity, and the findings are displayed in Table 2. Levene's test scores obtained ranged from .32 to 1.894. These values exceed the .05 criterion of significance. Therefore, it implies that the dependent and independent variables differed significantly.

Table 2. Homogeneity test for variance.

Variables	Test of Homogeneity of Variance		
	Levene Statistics	Sig.	Explanation
Learners' attitudes towards learning Physics	.318	.573	Homogeny
Pedagogical content knowledge of teachers	1.874	.172	
Content knowledge of teachers	.456	.988	
Pedagogical knowledge of teachers	.202	.654	

Qualitative Instrument

An interview guide consisting of participants' demography and semi-structured questions (Chenail, 2011) about PK, CK, and PCK and learners' attitudes were used. Face validity was ascertained by two experts whose comments were used to improve the tool. A valid tool was piloted to three different groups, and there were no differences among them, suggesting that the questions were suitable for the study.

Population and Sample

The population for the quantitative section comprised 2,212 secondary school learners from four schools (two private and two public) and 20 teachers. Three hundred twenty-seven (327) learners (148 males and 179 females) ages ranging from 15 to 17 with an average of 16 were chosen as a representative sample using the Krejcie & Morgan table (1970). Nineteen (19) teachers were purposively selected based on those teaching physics in those classes from which learners were selected. Also, the students' samples were picked from each school based on the proportionate size per school and class sampling technique (Brewer & Hanif, 1983). For confidentiality, the names of the schools were labelled A, B, C, and

D (Table 3).

Table 3. Number of learners per school A-D representation.

School	Sample selected
A	143
B	80
C	59
D	45
Total	327

Table 4 presents the detailed demography of the selected teachers.

Table 4. Teacher's profile including gender, age, qualification and teaching experiences.

Item		Frequency
Gender of the teachers	Male	15
	Female	4
Age in years	20-29	7
	30-39	6
	40-49	3
	50-59	2
	60-69	1
Highest level of education	Master's degree	-
	Bachelor's degree	7
	Diploma	12
Teaching experience years	0-5	10
	6-10	5
	11-15	3
	16-20	1
Qualification in ICT	Yes	5
	No	14

Data collection

Quantitative data collection was through questionnaires that were distributed to the respondents and collected after one hour. For qualitative data, three main questions and probe questions guided the study: 1) How do your learners feel about learning physics concepts in relation to their performance?; 2) What are the impediments and enablers in choosing the methods you use to teach physics?; 3) What is the influence of teachers' PCK on learners' attitudes towards learning physics? Each candidate was interviewed for 50 minutes (De Vos et al., 2011), and the information was audio recorded.

Data analysis

Quantitative data were analysed using descriptive statistics (percentage, means and standard deviations (SD)) and inferential statistics (Pearson correlations and regression analysis). Using Pearson correlation analysis, the strength and significance of the study variables were statistically evaluated (Kader & Franklin, 2008). The ability of the independent variables (PK, CK, and PCK) to predict the dependent variable (learner's attitude toward learning physics) was ascertained using a simple linear regression. Qualitative data was transcribed and thematically analysed (Braun & Clarke, 2006). The transcripts utilised open coding by reading line by line, followed by axial coding, where codes were grouped, and selective coding, where similar codes formed a theme and unlike codes formed different themes (Williams & Moser, 2019; Kibirige, 2023).

RESULTS AND DISCUSSION

The key result is that higher levels of PK and PCK impact learners' attitudes towards physics learning. These pedagogies teachers use should tap into learners' interest in physics. The quantitative results on teachers' PK and PCK had a moderately positive relationship with learners' attitudes concerning physics learning, whereas CK had a mild positive connection. Similarly, a regression analysis revealed that all three components of teachers' knowledge were positive: PK was the most significant predictor of learners' attitudes, followed by PCK, and CK was weakest in predicting learners' attitudes regarding physics learning.

Qualitative results revealed that CK helps teachers to integrate pedagogy in teaching and learning. Teachers' PK helps to facilitate learners to construct their knowledge, and it also allows for inquiry learning. Also, teachers can identify learners' prior knowledge and link it to the new knowledge, while teachers' PCK initiates basic and integrated skills in science (Kibirige & Rooyen, 2006). Specific research results include 1) Learners' attitudes toward learning physics, 2) Teachers' pedagogical knowledge, 3) Teachers' content knowledge, 4) Teachers' pedagogical content knowledge, and 5) Simple linear regression analysis in relation to the study's goals.

Learners' Attitudes towards Learning Physics

The dependent variable in this study was learners' attitudes towards learning physics. Figure 2 provides its descriptive statistics percentages derived from a 5-Likert scale questionnaire.

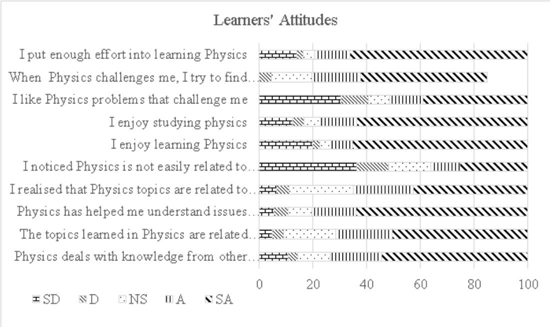

Figure 2. Learners' attitudes regarding physics learning.

Learners' attitudes presented an overall mean response of 3.69, which implies that there was a favourable association between teachers' knowledge and learners' perceptions towards learning physics.

The teachers were also asked about the perceptions of learners towards learning physics. Three themes emerged: excitement in learning physics; poor achievement demotivates; and learners' engagement in practical work, and each is represented by verbatim statements below.

"My learners show excitement during the lessons which implies that they feel good about the subject" (Teacher 3, School A).

"Examination results demotivate them because they perform poorly" (Teacher 5, School B).

"Whenever I appear in class with some laboratory apparatus, all my learners get excited and become engaged in learning activities" (Teacher 8, School D).

Teachers' Pedagogical Knowledge

Figure 3 outlines the study's purpose, which was to ascertain how learners' attitudes towards their teachers' content and methods used in physics and teachers evaluation of learners attitudes.

Most learners (67.9%) in Figure 3 agreed that teachers utilised various methods, such as questions and discussions, to see if they could easily understand physics concepts. The standard deviation of 1.251 and the mean score of 4.27 indicated that learners had a wide range of perspectives on the teaching strategies. With a mean of 4.35 and SD 1.14, this outcome was consistent with the percentage of learners (66.7%) who stated that their teachers' assessments helped them to comprehend the learning practices better.

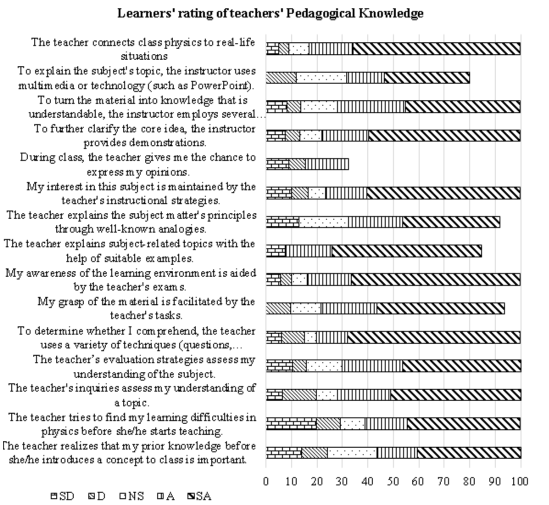

Figure 3. Learners reporting on teachers' pedagogical knowledge.

Since learners acknowledged that pedagogical knowledge strongly influenced their attitudes towards learning physics, the mean score across all questions measuring teachers' pedagogical knowledge was 3.96. The mean index was calculated using the average of the 15 elements used to describe pedagogical knowledge. This mean index value and the learners' attitudes toward learning physics were used to assess the first study hypothesis, shown in Table 5. The first hypothesis was:

H1: There is a correlation between teachers' PK and learners' attitudes towards learning physics.

Table 5 reveals a moderately positive link (r=0.52, p=.00) between teachers' PK and learners' attitudes towards learning physics. Hence, the researcher accepted the hypothesis that there is a correlation between teachers' PK and learners' attitudes towards learning physics. Also, when Teacher 3 from School A was asked what he believed was the effect of teachers' PK on learners' attitudes towards learning physics, the response was:

Table 5. Correlation matrix between teachers' pedagogical knowledge and learners' attitudes toward learning physics.

Variable Correlation		Teachers' Pedagogical Knowledge	Learners 'attitudes towards learning Physics
Teachers' pedagogical knowledge	Pearson's correlation, r	1	.521**
	P – value		.000
Learners' attitudes towards learning physics	Pearson's correlation, r	.521**	1
	P – value	.000	

** Correlation significant at 0.01 level (2-tailed)

"Teachers' PK helps the learners to acquire skills, which excite them, and their attitudes towards learning physics increases." (Teacher 3, School A).

Another teacher stated:

"The lack of PK limits and affects the teaching of physics. Teachers' PK, once properly used, helps learners to own their learning and make sense of it, especially when it is meant for competency development and is learner-centred." (Teacher 2, School C).

These assertions imply that teachers' PK influences learners' conceptualization of physics.

Teachers' Content Knowledge

Teachers' CK was assessed using eight questions that asked learners to rate their attitudes towards learning physics (Figure 4).

Figure 4 shows that most learners (76.1%) firmly believed that physics required advanced mathematical skills. It produced a mean of 4.6 and a standard deviation of .80, indicating a reasonable level of data reliability and moderate opinion variation among the learners. With an average of 2.45 and a standard deviation of 1.58, which suggested a significant variation in their opinions, many learners (40.70%) strongly disagreed that they did not like the mathematical components of physics. When asked if they disliked the mathematical part of physics, the learners' responses, as shown in Figure 4, were neutral, with an average of 2.60 and a standard deviation of 1.58. The SD of 1.58 showed high variance regarding the learners' opinions, which indicated low-reliability levels. The mean score for all the questions measuring teachers' CK was 3.72, indicating that learners generally agreed that teachers' CK significantly impacted their attitudes towards learning physics. Using the 15 items used to describe the CK of the teachers, the mean of the items was calculated, and the mean index was obtained.

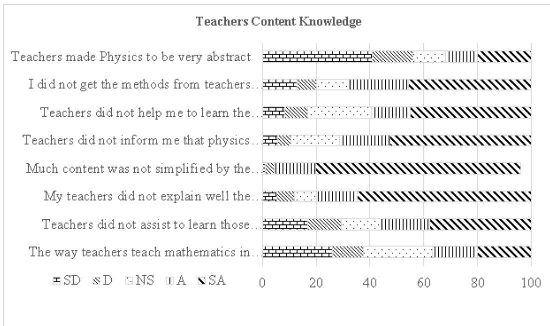

Figure 4. Learners' reporting on teachers' content knowledge.

A correlation between teachers' content knowledge and learners' attitudes is presented (Table 6).

Table 6 shows a weak positive relationship (r = .27, p = .00) between teachers' CK and learners' attitudes towards learning physics. A 95% confidence level (2-tailed) revealed the association to be statistically significant. Based on the data, the researcher accepted the hypothesis that "there is a substantial correlation between teachers' CK and learners' attitudes toward learning

Table 6. Correlation matrix between teachers' content knowledge and learners' attitudes on learning physics.

Variable	Correlation	Teachers' Content Knowledge	Learner Attitudes towards Learning of Physics
Teachers' content knowledge	Pearson's correlation, r	1	.269**
	P – value		.000
Learner attitudes toward learning of physics	Pearson's correlation, r	.269**	1
	P – value	.000	

**. Correlation significant at 0.01 level (2-tailed) physics."

For qualitative data, a physics teacher was asked to explain the impact of teachers' CK on learners' attitudes toward learning physics, and his response was:

"Teachers' content knowledge of the subject matter helps them to integrate it in the pedagogy by looking for suitable teaching methods and instructional materials to help them deliver the content to the learners in a comprehensible way" (Teacher 7, School D).

Teachers' Pedagogical Content Knowledge

Learners' responses to teachers' pedagogical content knowledge are presented in Figure 5.

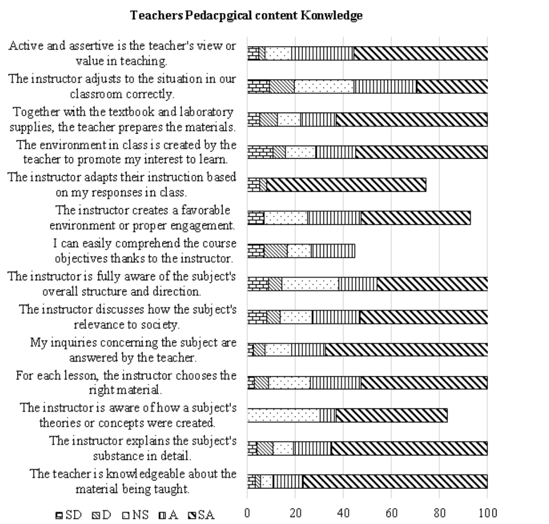

Figure 5. Learners reporting on teachers' pedagogical content knowledge.

The mean score across all the questions used to evaluate teachers' pedagogical content knowledge was 4.13. It suggested that many learners agreed that teachers' PCK significantly impacted their attitudes towards learning physics, and therefore, the third hypothesis stating that there is a correlation between teachers' PCK and learners' attitudes toward learning physics is accepted.

Pearson's linear correlation coefficient between teachers' PK and learners' attitudes towards studying physics is presented (Table 7).

Table 7 indicates that teachers' PCK (r=.51**, p=.00) is perfectly corrected with learners' attitudes toward learning physics. Additionally, when questioned about his thoughts on how teachers' PCK affects learners' attitudes towards learning physics, teachers responded as follows:

"*Teachers' PCK determines the understanding level of learners when teaching a given concept. Once learners understand the content taught, they get excited, and they develop a positive attitude towards physics"* (Teacher 2, School B).

"*Despite the excitement of studying physics, they are discouraged by poor terminal examinations"* (Teacher 2, School B).

"I use an inquiry-based teaching approach that engages learners to understand the physics" (Teacher 8, School D).

Analyses of Simple Linear Regression

A simple linear regression model determined how teachers' knowledge impacted learners' attitudes toward learning physics. The simple linear regression of teachers' scores predicted PK: $R2 = .26$, $F(1, 325) = 4.55$, $p = .00$; PCK: $R2 = .26$, $F(1, 325) = 4.18$, $p = .00$; and CK: $R2 = .13$, $F(1, 325) = 2.85$, $p = .01$. Thus, these results show that teachers› knowledge of PCK and PK accounted for majority of the variation, while CK had the least. The findings showed that the teachers› knowledge is crucial if there is to be a significant improvement in learners› attitudes toward learning physics and shaping their career paths in physics.

The researchers also established the correlation coefficients (correlation model) to show how each construct of the teachers' knowledge affects learners' attitudes towards learning physics (Table 8).

Table 8 shows that PCK, CK and PK were all positive significant (p <.05) predictors of learners' positive attitudes towards learning physics,

Table 7. A correlation matrix for teachers' pedagogical content knowledge and learners' attitudes toward learning physics.

Variable	Correlation	Teachers' Pedagogical Content Knowledge	Learner Attitudes Toward Learning of Physics
Teachers' pedagogical content knowledge	Pearson's correlation, r	1	.51**
	P – value		.00
Learners' attitudes toward learning of physics	Pearson's correlation, r	.51**	1
	P – value	.000	

**. Correlation significant at 0.01 level (2-tailed) where PK was the strongest predictor (βeta = 0.30).

Table 8. Results of the correlation coefficient.

Parameter	Standardized coefficients Beta	Sig.
Constant, a		.001
PCK	.269	.000
CK	.135	.005
PK	.296	.000

This study sought to examine teachers' physics knowledge and learners' attitudes toward learning physics in sampled secondary schools in Fort Portal City, Uganda. The study found a positive correlation between learners' attitudes toward learning physics and the PK, and PCK accounted for higher variance compared to CK. The learners' attitudes were of a mixed nature as exhibited in three themes from qualitative results: excitement, demotivated by the poor physics results, and their engagement in practicals. The discussion is based on three knowledge contexts: PK, CK and PCK, learners' attitudes towards learning physics and mixed learners' attitudes towards physics.

Teachers' Pedagogical Knowledge and Learners' Attitudes

Quantitative results show a moderate relationship between teachers' PK and learners' attitudes about learning physics (Figure 3) and a strong correlation (βeta = 0.30) (Table 8). It means that teachers with a deeper understanding of the teaching strategies have higher chances of improving learners' attitudes toward learning physics and achievements. Similarly, the qualitative results show that teachers with better PK promote learning since they can trigger learning skills like communication, observation, measurement, and interpretation. It means that the way teachers teach learners impacts learners' attitudes towards learning. These observations are similar to the study by Derrick (2021), who asserts that teachers with good pedagogical decisions influence high-quality learning. Obielodan (2020) argues that teacher quality is positively related to PK and enhances learning. Also, these findings substantiate Keller et al. (2017), who affirm that high teachers' PK enhances learners' academic achievements.

Teachers' Content Knowledge and Learners' Attitudes

The quantitative results show that teachers' CK and learners' attitudes about learning physics have a weak positive link (Table 6). It implies that teachers with a strong CK enhance learners' attitudes towards physics. These outcomes parallel the qualitative findings in this study. These results are like Kirschner *et al.* (2018) and Nandugwa›s (2018) findings, which show that poor teachers' CK produces poor learners' achievements. In fact, CK is a crucial certification criterion for high achievements (Phelps et al., 2014). Learners get excited and engage in practical work. Despite these positive gestures, their terminal and national Examination results are poor. This observation is not surprising because teachers› CK does not link to the learners' everyday experiences (Adolphus, 2019).

Teachers' Pedagogical Content Knowledge and Learners' Attitudes

Quantitative results revealed a moderately positive relationship between learners' attitudes about learning physics and teachers' PCK. It suggests that teachers who possess a combination of pedagogy and subject matter impact learners' attitudes toward physics. This finding aligns with the qualitative results where learners are excited and get engaged in studying physics.

A study conducted by Voss (2017) also emphasised that the association between learners' perspectives on learning physics and teachers' PCK are vital for faster conceptualisation and promotes skills development among learners. Furthermore, Buaraphan and Roadrangka (2019) reported that PCK enables teachers to design activities that challenge learners while enhancing their attitudes toward science subjects. This is because highly knowledgeable teachers can anticipate learners' challenges and respond when problems arise using appropriate strategies and concepts. Therefore, teachers with a stronger PCK contribute to learners' comprehension of concepts, leading to improved attitudes toward learning physics. It consequently promotes physics learning with enjoyment and excitement that enhances good learners' academic achievements (Azam, 2020). While issues raised in this study are vital to enhancing academic achievements, there are other issues like administration, classroom environment, infrastructure, self-efficacy and motivation (Kwarikunda et al., 2020), which were not the focus of this study but may have far-reaching impacts on learners' academic achievements and may need further study.

CONCLUSION

The quantitative results established that teachers' PK and PCK contributed more than CK to learners' achievements and excitement about learning physics. Thus, teachers' pedagogy and content are needed to improve learners' attitudes and academic achievements. Also, the qualitative results show that PK, CK, and PCK have a positive impact on learners' attitudes about learning physics.

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