

## Analysis of supervisor's written feedback addressing pre-service science teachers' pedagogical content knowledge during teaching practice

Nathaniel Ayodeji Omilani <sup>1\*</sup> , Stella Nneka Ogbonna <sup>2</sup> 

<sup>1</sup> Department of Science and Technology Education, University of Ibadan, Ibadan, Oyo State, NIGERIA

<sup>2</sup> Center for Degree Program, Federal College of Education, Osiele, Abeokuta, Ogun State, NIGERIA

Received 02 January 2023 ▪ Accepted 17 July 2023

### Abstract

The feedback received during teaching practice (TP) has a lasting impact on pre-service teachers' teaching knowledge and practice among the learning experiences of the teacher education program. This study analyzed written feedbacks offered by supervisors to pre-service science teachers (PSTs) (biology, chemistry, physics, health education, and mathematics) during TP observation generally, but with particular attention to those addressing pedagogical content knowledge (PCK). The study adopted a phenomenological design of qualitative research and written feedback in 40 PSTs' lesson notes were analyzed using deductive thematic analysis. Apart from the few written feedback related to PCK, some were not specifying the teaching knowledge or practice they intend to correct or affirm. Majority of the written feedback addressed general pedagogical knowledge. The written feedback related to PCK was more generic to the science discipline than topic-specific. Conceptual teaching strategies and representation were the components of PCK addressed in the feedback. Based on the findings, it was recommended that the college supervisor should avoid offering feedback that specifies no direction of improvement during the supervision of PSTs during practicum.

**Keywords:** supervisor's written feedback, pre-service science teachers' pedagogical content knowledge, teaching practice

## INTRODUCTION

It has been demonstrated that teacher education and professional development programs contribute greatly to the changes in teachers' knowledge and practice (van Driel, 2014). Practicum also known as teaching practice (TP) is a major professional development program that greatly impacts the knowledge and practice of pre-service science teachers (PSTs). This is because TP is the melting pot in which PST integrates all the knowledge and skills acquired during training into the classroom setting. Through TP, PST commences the developmental journey from being a novice science teacher to an expert in a real classroom setting. Afolabi (1999) and Darling-Hammond (2010) asserted that TP enables the student-teacher to get acquainted with the practical knowledge of teaching and learning processes including lesson plan preparation, presentation, class management, communication skills, evaluation, and the required

personality of professional teachers. This is the reason most PST education includes TP, a supervised field experience (van Driel, 2014). The supervised field experience is designed to develop the professional knowledge of PST. To this end, PSTs are exposed to two six weeks of TP first at the beginning of their third year and second at the beginning of the fourth year of four years undergraduate program in Nigeria.

TP occurs in a social context, apart from the college supervisor, the cooperating teacher, school administrator, and students are also among the social agents that make the practicum experience a positive one. A positive practicum experience is that which bridges the gap between the theory of teaching and practice (Clarke et al., 2014; Koc, 2012; Nghia & Tai, 2019). The in-service teacher who teaches the same subject as PST in the practicum school is referred to as the cooperating teacher; plays a huge role in making the experience a positive one. Their roles are not limited but

### Contribution to the literature

- In this study, based on the type of teaching knowledge the written feedback addressed, we analyzed the written feedback that teaching practice supervisors offered to preservice science teachers during teaching practice after the observation of their teaching.
- Many of the supervisor's written feedback addressed pedagogical knowledge and very few addressed pedagogical content knowledge; there was written feedback that failed to address any teaching knowledge.
- The few Pedagogical Content Knowledge related feedback offered by supervisors addressed the conceptual teaching strategy, and representation and analogy components of Rollnick and Mavhunga (2016) were more of discipline and subject-specific; very few were topic specific.
- Many of the supervisors who offered PCK related feedback were experts in science education.

include mentoring PST during the practicum, offering guidance to PSTs on lesson note preparation, suggesting what ought to be done both before and after the lesson delivery and observing the classroom delivery for the purpose of reflection. However, among all the social agents that contribute to the professional development of pre-service teachers during practicum, the university supervisor appears to have the highest number of roles. Kadushin (1976) listed administrative, educational, and supportive roles as the three major roles of a college supervisor during TP. The role of the university-based supervisor is very important in a program that is a supervised field experience. These three roles are intertwined and inseparable. TP is a course, and the assessment of the supervisor solely determines the grade of PST in Nigeria. The educational and supportive roles are strictly to ensure that PST teaching knowledge is developed.

The assessment of PST's practicum by the supervisor is in two folds. Firstly, based on the pre-specified indices indicated in the faculty's rating scale, the supervisor grades PST's teaching knowledge and skills to generate a score after observing PST. Apart from the generated score, the supervisor is expected to give immediate oral and written feedback to PST. The written feedback is documented in PST's practicum lesson note and oral feedback given by the university supervisor elaborates the written feedback. The written feedback in PST's lesson note is qualitative in nature. Morton and Kurtz (1980) averred that during supervision the feedback provided is a form of instruction showing the supervisee's deficit resulting from a lack of teaching knowledge or skills based on the observation of the supervisor. The feedback also reinforces the knowledge and skills, which PST gets right. Hence, the judgment of the university supervisors of the practicum performance of the pre-service teachers determines the adjustment, which PST makes to their knowledge and practice during practicum among other things. Hence, the college supervisor plays a lead role in professional development compared to other social agents involved.

Martin and Russell (2018) stated that lesson content and classroom management are first-order issues for

virtually every teacher candidate. Hence, the supervisor's feedback, which addresses PST leading concern ought to be subjected to analysis so as determine its potential to improve any deficit in that area that concerns PST the most. Martin and Russell (2018) also documented the testimony of a former student of one of the authors (Russell) whom he supervised on practicum 20 years ago. The pre-service teacher who is now an experienced teacher says she still recalls the criticism of the supervisor during her practicum two decades ago and the criticism still guides her classroom practice.

Without any doubt, the feedback provided by the supervisor during practicum is associated with the entire professional development of PST. This includes the development of general pedagogical knowledge, subject matter knowledge, pedagogical content knowledge, lesson planning, and much more. Thus, the supervisors' feedback is expected to address one or more teaching knowledge and skills. Among all the categories of teacher knowledge and skill, which the feedback can address, this study is considering pedagogical content knowledge (PCK) as a crucial determinant of the quality of supervision. This is not a downplay feedback addressing other categories of teaching knowledge and skills, but having no feedback related to PCK in the presence of others may make PST not develop a very significant teacher knowledge base that integrates other teaching knowledge bases.

Shulman (1987) described PCK as a construct that goes beyond subject matter knowledge, but it is about how to make the content learnable to the learners. Gess-Newsome (2015) defined PCK as the knowledge, reasoning, and planning that informs teaching a particular topic in a particular way for a particular purpose to a particular student for enhanced student outcomes. Among all the teacher's knowledge that Shulman (1987) described, PCK is the most researched. In the original view of Shulman (1987), PCK is a form of professional knowledge, and it has two components. These are knowledge of appropriate topic-specific instructional strategies and representation; and understanding of students' difficulty and preconceptions. Several empirical studies have

measured PCK of science in-service and pre-service teachers. While some measured PCK in isolation as head knowledge others measured it in a specific context as a social asset in the classroom (Chan & Hume, 2019). PCK can be subject-specific, domain-specific, and topic-specific (Veal & MaKinster, 1999).

Depaepe et al. (2013) conducted a systematic review of the literature on pre-service teachers' PCK. ERIC, Web of Science, and PsycInfo were the three databases consulted for the review. The outcome of the review established that PCK is usually addressed in research related to PCK courses (also known as method courses in the US and subject matter for teaching in Europe), pre-service teacher contact with college supervisor and cooperating teachers during practicum, and teaching experience reflection. This implies that the interaction of the college supervisor with PST is a major source of the development of PCK among others.

van Driel and Berry (2019) in a study that focused on the development of PCK in the context of PST program remarked that very few studies have discussed the impact of practical teaching or field experience on PCK of pre-service teachers most especially within the context of what PSTs make out of the feedback. Akkoc and Yesildere (2010) is one of such few studies with a finding that pre-service mathematics teachers developed PCK in algebra as a result of mentoring by a college supervisor during TP, and the discussion of the practicum experience in the university mathematics method classroom. The reported improvement in PCK by Akkoc and Yesildere (2010) was observable in three components of PCK of mathematics pre-service teachers' understanding of students' difficulty, curricular knowledge, and assessment skills. Unlike Akkoc and Yesildere's (2010) study, no attempt will be made to show a direct link between areas of improvement of PST based on supervisors' written feedback that is PCK specific. Rather this study attempts a detailed exploration of the feedback provided by the college supervisor and an analysis of written feedback that is related to PCK. The justification for this is that apart from understanding the effect of the written feedback related to PCK on PST knowledge and practice, it is important to understand the feedback offered by supervisors. This will provide a window through which the practice of offering feedback will be better understood.

This study adopted Rollnick and Mavungha's (2013) PCK component, which includes students' prior knowledge (PK), and misconceptions, curricular saliency, understanding what makes the topic easy or difficult to understand, representations including analogies, and conceptual teaching strategies. The feedback of the supervisor was analyzed to see which of the component it addressed. In addition to the component, this study also examined if the written

feedback addresses the topic or subject PST is teaching, or just the science discipline.

## THEORETICAL FRAMEWORK

Refined consensus model (RCM) of PCK (RCM of PCK) is the basis for this study. According to this model, there are three realms of PCK, and these are enacted, personal, and collective PCK (cPCK). Enacted PCK (ePCK) refers to the specific knowledge and skills utilized by an individual teacher in a particular context with a particular student with the goal for those students to learn a particular concept, collection of concepts or a particular aspect of the discipline (Carlson & Daehler, 2019). The second realm of PCK is the personal PCK (pPCK). pPCK is the reservoir of knowledge and skills that the teacher can draw upon during the practice of teaching (Carlson & Daehler, 2019). pPCK of two individuals is rarely the same except they undergo the same training or work in the same classroom, which enforced a particular educational policy. pPCK and ePCK intersect and influence each other. For instance, the experiences of teachers during classroom teaching can cause them to adjust pPCK after reflecting on ePCK used in the classroom. cPCK is the last realm of PCK identified in RCM. This describes a well-articulated and specialized knowledge base for teaching science that many science educators have agreed upon. The three realms of PCK are expressed in the three domains of PCK identified by Veal and MaKinster (1999).

During supervision, ePCK of PST among other knowledge bases is observed and assessed by the supervisor. ePCK of PST provides several pieces of information and among them are some pPCK and cPCK in the topic, subject or science field. Since it is impossible to observe all pPCK and cPCK that PST has gained during the teacher education by observing a forty or eighty minutes lesson. However, during instruction, the college supervisor is more experienced and can see the strength of PST and areas of need.

Based on the foregoing, the college supervisor's feedback is of good quality if it has the potential of improving the realms of PCK across any of the three PCK domains as well as other knowledge and skill base (Sadler, 1998). Such feedback will be based on many factors and notable among them is the ePCK that the college supervisors assume they could have used in the same context, and their pPCK and cPCK. In short, PST's PCK is being read through the lens of supervisors' PCK. Learning oriented field assessment framework posits that the feedback, which the supervisor provides is more to develop the professional practice of PST. Hence, the feedback is like an instruction given by the supervisor, but now in the role of teacher to PST. The receiver should not be the only one reflecting on the feedback, the provider must also do. While the receiver reflects for improvement of instructional delivery, supervisor

offering the feedback must also do the same. Unlike PST, the self-evaluation of the supervisor is for the purpose of improving the effectiveness of their role as the teacher, based on the peculiar demands during a learning-oriented field experience assessment (Tang et al., 2006). In their meta-analysis, Burns et al. (2016) found that 84% (n=27) articles indicated that providing instructional feedback was the leading task of the university supervisor under the theme of targeted assistance to the pre-service teachers during practicum.

Regarding the choice of the analysis of written feedback, and not oral, even though it has been documented that oral feedback is richer than written feedback (Agricola et al., 2019; Spiteri, 2017). Among the merits of oral feedback is that it allows for dialogue while written feedback is usually a monologue. On the other hand, some research work reported the empirical superiority of written feedback. An example of this is the study of Al-Wadi (2018), which established that university supervisors who used written feedback were able to reinforce in-service teachers running postgraduate diplomas in education on practicum in Bahrain. The choice of analyzing written feedback is that of convenience as far as this study is concerned. This is because of the huge technology required for recording and transcribing the oral feedback of the college supervisor. Not mentioning the guidelines and consent issues that can surround a college supervisor being recorded. More importantly, the research may not reflect the real state of things if the supervisor is aware that their feedback will be recorded.

## **PREVIOUS STUDIES ON WRITTEN FEEDBACK**

The feedback according to Soslau (2012) provides the opportunity for a reflective discourse. In addition to this, Burns et al. (2016) reiterated that feedback fosters critical reflection, which consists of routines that promotes PSTs' reflection on the impact of their action as well as larger sociopolitical and historical context. Feedback can be in various forms during TP and the advantages of various types have been researched.

In terms of classification, various indices have been used to categorize feedback during practicum. Primarily, many studies categorize supervisors' feedback according to their pedagogical purposes they serve. Examples are confirmatory and corrective; such feedback is either confirming or correcting PST knowledge or practice during classroom delivery (Kurtoglu-Hooton, 2004, 2008); and confirmatory + corrective; such feedback is having dual focus (Spiteri, 2017). Gurken (2018) added the timing of the feedback coming up with immediate and delayed corrective-confirmatory feedback. Outside Nigeria, several studies have been carried out on a practicum supervisor's talk during post-observation conferences using various

approaches. For example, Waite (1992) analyzed it anthropological linguistic perspective, Holland (1988) used discussed analysis and Spiteri (2017) adopted corpus linguistics perspective. Kurtoglu-Hooton (2008) on the other hand, categorized feedback based on if it will make PST adjust their professional knowledge and skills or retain it. Kurtoglu-Hooton (2008) called the former corrective and the latter confirmatory feedback respectively. Glenwright (1999) classification are those feedbacks expressing approval, expressing reservations or criticism, and giving advice. Beyond, the literal categorization identified in the literature, it is important to consider the content of the feedback and which teaching knowledge of PST the feedback intends to develop. The knowledge required for classroom teaching includes content knowledge, pedagogical knowledge, curricular knowledge, knowledge of student knowledge of schools, and PCK (Lederman & Lederman, 2015). PCK was derived from the interaction of the first five knowledge domains, and it is the central dimension of teacher professional knowledge (Lederman & Lederman, 2015; Weitzel & Blank, 2019). Hence, any feedback of the practicum's supervisor that does not improve PCK of the supervisor is doing very little to PSTs' professional development.

Primarily, this study intends to add to the existing literature the details of the exact teaching knowledge that the supervisors' written feedback intends to confirm or correct in the broad categories of the existing teaching knowledge in Nigeria. In addition, it intends to analyze the feedbacks that are related to PCK to understand their nature. Studies that show how college supervisors reflect on the feedback provided during practicum are not available in Nigeria and it is expected that this present study will open up the conversation and research on the assessment of the college supervisors' feedback. Such that the supervisors' written feedback are analyzed to see if it has the potential of developing a very important component of PST's professional knowledge objectively.

This study is equally important because Lederman and Lederman (2015) challenged science educators globally to research the unexplored area of science teacher education. In Nigeria, empirical studies focusing on this aspect of PST's education, practicum, and specifically on the analysis of practicum supervisors' feedback are rare. A study that is a little bit close is that of Lawal et al. (2010). Their study focused on ESL pre-service teachers' view of TP supervision assessment and the findings revealed that the ESL pre-service teachers rated supervision and assessment very low because of inadequacies in the number of visits, lack of feedback, and low level of interaction with the university supervisors. Lawal et al.'s (2010) study relied on PST opinion in the questionnaire and did not take a qualitative look at the feedback, which the ESL pre-service teacher rated poor.

## Research Questions

1. Apart from PCK related written feedback, what are the other type(s) of feedback that college supervisor provided to PSTs during TP supervision?
2. Which domain and components of PCK were addressed by the supervisors' written feedback?

## Nigeria Teacher Preparation and Affiliated Degree Programmes for Preservice Teachers

In Nigeria, colleges of education usually run educational degree programs in affiliation with conventional universities. Statutorily, colleges of education prepare teachers for basic education. Basic education is the compulsory education the child is exposed to between the ages of 6-15 years. The basic education is in three levels: three years lower basic (primary one-three), three years middle basic (primary four-six), and upper basic (J.S.S. one-three). PST trained in the Nigerian College of Education are expected to play the role of the specialist teacher at the level of basic education but are unqualified to teach any science subject at the post-basic level of education in Nigeria. The post basic education usually referred the senior secondary school education in Nigeria (senior secondary school one-three). With the population explosion in terms of the number of students in the senior secondary school, there is a need to meet up with the demands for qualified teachers. The faculty of education in the conventional university is not able to produce enough teachers. Hence, colleges of education run degree programs in affiliation with the conventional university. The students in the college of education running a Bachelor of education are not different from those in the conventional university, in terms of the admission policy, curriculum, and program duration. To ensure standards, the faculty of education in the conventional university of affiliation moderates both the question and result of students from the affiliated colleges of education running a degree program in science education and other courses.

## Context of Practicum in Nigeria

In most conventional universities in Nigeria, pre-service teachers undergo practicum at the beginning of the third year and final year spending six weeks at each of the levels. During the six weeks, the lecturers go on the supervision of the pre-service teachers. This same system is replicated in colleges of education running degree programs in affiliation with conventional universities.

During the six weeks, college supervisors visit PST to make informed decisions regarding aspiring teachers' progress and performance as prospective classroom teachers. Each of the visits also serves the dual purpose of instruction and assessment. The college supervisor is expected to generate three scores based on the classroom

assessment sheet provided by the college (Clift & Brady, 2005). The assessment sheet often used in Nigeria for pre-service teachers' supervision is a rating scale in which the rater rates PSTs on a scale of one through five. PST is rated on the following rubrics: lesson preparation (availability of lesson notes, appropriateness of contents, and stating the teaching procedures), teaching and learning (introduction of the lesson, lesson progression, subject matter mastery at the level of delivery, and appropriateness of learning activities), teacher-learner interaction (communication, reward and reinforcement, classroom arrangement and management and lesson presentation according to the stated procedure, Instructional material (utilization, adequacy, and suitability assignment/evaluation, teachers personality and conclusion. There is also a small space one-quarter of an A4 page, where the supervisor is expected to provide qualitative written feedback to the college. PST also have a place in their note in which the same qualitative feedback is written.

Unlike the absence of clarity on who should supervise the pre-service teachers during practicum reported by Burns et al. (2016); the college of education assigns senior academic staff with a doctoral degree in any field to supervise the pre-service teachers during practicum. The supervisor is always matched to a geographical location and/or schools; the supervisor is expected to supervise all PSTs on the list, irrespective of their discipline. Cases, which the college supervisor and PST are of the same subject area are just coincidental. In terms of qualification, all the supervisors have a form of teacher education training, but not all are specialized in education or science education. The postgraduate diploma in education (PGDE) and Nigerian certificate of education are the educational qualifications of those who do not specialize in education at the master's and doctoral levels.

Equally, the college supervisor is expected to contribute to the professional development of the pre-service teacher by providing guidance and tutelage, where necessary after observing PST's classroom teaching. The feedback is both oral and written. The oral feedback according to Soslau (2012) provides the opportunity for a reflective discourse. In addition to this, Burns et al. (2016) foster critical reflection, which consists of routines that promote PSTs' reflection on the impact of their actions as well as larger sociopolitical and historical context.

## METHODOLOGY

### Research Design

This study is part of a bigger study that employed a mixed-method research design. The qualitative stage preceded the quantitative stage. And the qualitative stage of the study is reported in this paper.

**Participants and Data Collection Instrument**

This study was conducted among final-year preservice science teachers enrolled at the Centre for Degree Programme of Federal College of Education Osiele, Ogun State, during the 2018/2019 academic year. PSTs were required to submit the lesson notes used during TP, which usually contain the written feedback of the college supervisor. Out of the 132 PST in the final year in college, where the study was conducted, only 40 volunteered to submit the lesson used during the years three and four TP of the degree program. The subject areas of the teachers who volunteered to submit their TP lesson notes are chemistry (12), physics (eight), biology (11), health education (five), and mathematics (four). A lesson note is expected to contain four college supervisors' written feedback. This is because, during each TPs, a PST is expected to be supervised twice. The analysis of the lesson notes of the volunteers revealed that there are one hundred and thirteen supervisors' written feedbacks were in the 40 PSTs' TP lesson notes. The reason for this is that not all PSTs enjoyed the specified number of supervisions. If all had enjoyed the required numbers of supervision a total of 160 written feedback is expected. The written document was subjected to thematic analysis at the qualitative stage.

**Data Analysis**

A deductive approach of thematic analysis was used to analyze the written feedback of the college supervisor. The study adopted Braun and Clark's (2006, 2022) reflexive thematic analysis method as the framework for conducting analysis. The first stage of the framework involved the researcher familiarizing themselves with feedback in PST lesson notes. After this, the codes were developed based on literature of teaching knowledge. The researchers were interested in feedback that can address the main teacher's professional knowledge: pedagogical, content, and PCK. The supervisors who wrote the feedback were not interviewed; the written feedback was conceived latently such that underlying meanings of the text were only inferred.

In cases, where further clarification is required to make meaning of the comment, PST who owns the lesson note was interviewed to make a sense of the context in which the feedback was offered. This interview did not probe into the meaning that PST made of the written feedback, nor was it transcribed. The information on the qualification and specialization of the college supervisor was obtained from the college database since their names were written at the end of the feedback. At the end of the coding process, the central themes used to classify the type of written feedback are general pedagogical knowledge, and PCK.

**Codebook Generation**

The initial code sources are from literature. The existing literature and the initial analysis of PSTs practicum notebook revealed that feedback is either correcting or affirming PST's classroom delivery and planning of the lesson. In development of codes, study went further to consider, which category of teaching knowledge is supervisor feedback is addressing. Based on this guideline, two major themes emerged:

1. written feedback correcting or affirming PCK of PSTs and
2. written feedback correcting or affirming the general pedagogical knowledge of PSTs.

These are the initial categories or themes. The researcher began using the two themes on the ten practicum notes of 10 PSTs. In this process, the researcher found out that some feedback did not address either of the categories initially specified and were not addressing any specific teaching knowledge; instead, they were written by the college supervisor not just to leave the space for written feedback empty. This led to the fourth stage in Braun and Clark's (2006, 2022) reflexive thematic analysis method, which is the development and review of themes. Based on this, the third theme emerged. The third theme is termed unspecifying. The feedback that fits into this theme is referred to as unspecifying because they neither provoke nor guide PST to adjust any type of teaching professional knowledge. They were neither affirming nor correcting also. **Table 1** provides further details, including the

**Table 1.** Codebook used for thematic analysis

Theme	Code label	Definition	Description	Examples
PCK related feedback	Written feedbacks, which either affirms or corrects PST's PCK	Supervisors' written feedback that is either affirming or correcting PSTs classroom practice/lesson planning about content, which PSTs is teaching. This does not exclude general pedagogical knowledge. This also involve feedback that is related to content knowledge.	Comments that will provoke PST on interpretation & transformation of subject matter knowledge in context of facilitating students learning.	Stating instructional materials required for a given content.
Pedagogical knowledge related feedback	Written feedbacks, which either affirms or corrects PST's pedagogical knowledge	Supervisors' written feedback that is either affirming or correcting PSTs classroom practice/lesson planning without reference to content, which PST's is teaching.	Written feedbacks, which have addresses general principles of teaching without any reference to content that PST taught during observed lesson.	Corrective feedback that a PST has not correctly stated behavioral/instructional objectives of lesson using a measurable verb.

**Table 1 (continued).** Codebook used for thematic analysis

Theme	Code label	Definition	Description	Examples
Unspecifying written feedback	Written feedbacks, which neither affirms or corrects PST's pedagogical knowledge nor PCK	This is supervisors' feedback written just for sake of not leaving space, which is left for supervisors' written feedback void. Feedback contributes nothing to knowledge base of PST.	Feedback that does not provoke concern for adjustment in any area of classroom practice. No direction of change at all.	Writing word excellent on PST's lesson note without stating what PST did or wrote excellently.

**Table 2.** Framework for interpretation of written feedback that is centered on PCK

SN	Supervisor discipline or feedback number	PST's teaching subject/topic	PCK related feedback of supervisors			
			PCK component	Field addressed in feedback		
				General science	Specific subject	Topic specific
			Conceptual teaching strategies			
			Students' prior knowledge			
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand			
			Representation including analogies			

definition of themes, description of themes, and examples.

**Reliability**

The reliability of the codebook was determined when two independent raters used the codebook to analyze the written feedback of a supervisor in a PST's lesson note. For the two raters, there was an agreement of 0.8 using Cohen's kappa. This implies a very strong agreement between the rating of the two raters rating. The fifth stage of Braun and Clark (2006, 2022) involves refining, defining, and naming themes. The boundary of themes in the codebook that was already generated was defined at this stage. This refinement is necessary because the written feedback of the supervisors sometimes addresses more than one theme. Anytime such occur in this study, the following guidelines were used for categorization.

1. When the supervisor offered written feedback related to PCK in the presence of other themes (pedagogy and unspecifying) PCK related feedback was first analyzed, and afterwards other themes were analyzed. Such feedback is categorized as PCK related primarily.
2. When the supervisor offered written feedback related to PK in the presence of unspecifying theme PK-related feedback is first analyzed and afterward the un specifying themes were analyzed. Such feedback categorized as PK related.

Since the interest of the study is focused on PCK feedback, PCK feedback were further analyzed using the framework in **Table 2**. This is to understand which type of PCK and components of PCK are the feedbacks related to PCK are addressing

**RESULTS**

**Table 3** is a transcript of the supervisors' written feedback and PST's teaching subject. The first two items in **Table 3** (SN 1 and 2) transcripts in **Table 3** contain PCK-related feedback offered by supervisors to PST. For the transcript in SN1, the supervisor's discipline is chemistry and integrated science and PST being supervised is a pre-service physics teacher. The topic the physics pre-service teacher taught during the practicum observation and supervision is displacement and coordinates. From the written feedback, the supervisor started by defining learning generally, as a PK-related comment. The feedback went further to describe the peculiarity of teaching physical sciences; a PCK comment related to the conceptual teaching strategy that is subject-specific. The second feedback went further to suggest a specific learning activity in which the pre-service physics teacher can make learners contextualize the concept of coordinates and displacement, a PCK-related comment that bothers on the knowledge of representation that is also a topic specific.

From the feedback, the pre-service physics teacher is likely to deduce that using lines (vertical or horizontal) drawn on the board is not as effective as allowing the learner to use their pen. And this way abstraction will be minimal when the learners are to distinguish between the two axes. The written feedback equally guided the learner on blackboard use. "you were talking to the board throughout the time you were facing the board".

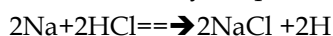
The second of written feedback (SN2) was offered by a supervisor whose first degree is in biochemistry while PST being observed is a pre-service chemistry teacher. The pre-service chemistry teacher taught chemical equations and symbols during the supervisor's visit. PCK-related feedback addressed a very sensitive issue, which is the symbolic representation of the element Helium. During the lesson, PST wrote the symbol of Helium incorrectly as HE. This is PCK-related feedback

**Table 3.** Nature of written feedback, which supervisors provide pre-service teachers

SN	Transcription of supervisors' written feedback/supervisor expertise	Subject/topic taught by PSTs	PSTs' knowledge addressed	N	Supervisor's qualification
1	"Learning is a transition from known to unknown. Ensure that unknown is well established. Physical science is well contextualized when learning experience is personal. Your students have a pen, which they can place on their tables (vertically/horizontally). Before you start using board, they can try it with their pen. Rain also falls vertically, this is an example they see daily. Teaching of physics should not be abstract. I am confident that you are a master of subject matter, but I want you to do more. You were talking to board throughout time you were plotting graph (backing students & explaining things on board)."	Physics / displacement & coordinates	PCK	13	Bachelor of science education, masters in science education & PhD in science education all with specialization in chemistry. A teacher of chemistry, physics, mathematics, & integrated science at secondary & college of education levels
2	"Letters used as symbols to represent elements must be correctly written otherwise, they cannot be said to represent elements. For instance, helium is He NOT HE (which pre-service chemistry teacher wrote in her lesson note). You need to learn how to manage & control your class while teaching. There was a lot of distraction & side talks during teaching. This equation is wrong: $2Na+2HCl \Rightarrow 2NaCl+H$ . Please correct. It is obvious that did not take time to master concepts before teaching them to learners".	Chemistry/chemical equation & symbols	PCK	13	Bachelor of Science in biochemistry, postgraduate diploma in education, masters & PhD in early childhood education
3	Good use of real object as instructional material, which made lesson more practical oriented & learners' friendly. But teacher should be able to create better link between learner's previous knowledge & current discourse.	Chemistry / particulate nature of matter	General pedagogical knowledge	13	BEd, Med, 6 PhD in social studies
4	Well prepared	Diffusion	Unspecifying	16	
5	Lesson note is well prepared, checked, & supervised by me.	Human kinetics & health education / physical health	Unspecifying	16	PhD in English language
6	A well-planned & efficiently presented lesson	Atomicity	Unspecifying	16	PhD in English language

Note. n: Total found in study (113)

that is topic specific. It covers the curriculum the saliency component of PCK. The feedback showed the pre-service chemistry teacher the correct symbol, which is He. The feedback equally addressed the wrong chemical equation written by the pre-service chemistry teacher.



The supervisor circled the 2H on the product side stating that it is wrongly written. PST reported that the supervisor had an oral dialogue that made the pre-service chemistry teacher realize that H<sub>2</sub>(g) is the correct representation of hydrogen gas, which is the product of the reaction. In addition to PCK-related feedback, the supervisor also raised the issue of class control, this is related to PK. Another PK related written feedback that the supervisor offered was the written comment to PST that there was side talk among the students while the instruction was ongoing.

The third written feedback (SN3) in **Table 3** addressed only pedagogy without relating it to any content being taught. The pre-service chemistry teacher

taught the separation technique under the broad topic particulate nature of matter during the supervisor's observation and assessment. The comment was pedagogically related because it insisted that the pre-service chemistry teacher being observed should relate the new instruction to previous learning. The pre-service chemistry teacher was supervised by a college supervisor whose discipline and area of specialization is non-science (social studies).

The fourth written feedback (SN4) is an unspecifying written feedback because the only remark written by the supervisor is that the lesson is well prepared. This type of feedback does not elicit any teaching knowledge or skill base, which the supervisor intends to correct or confirm. Transcript SN5 in **Table 3** showed another unspecifying feedback. The supervisor directed the written feedback to the lesson note and not the teaching of PST.

"Lesson note is well prepared, checked, and supervised by me"



This written feedback addressed only the lesson note. Although the supervisor (a doctoral degree holder in the English language) indicated that the pre-service health educator lesson note was well prepared, it is impossible to ascertain if the supervisor read through and understood the technicalities of health education. Above all, the written feedback is directed at the presentation of the lesson by PST. A good lesson note does not translate into excellent classroom delivery.

The preparation of lesson notes is at the pre-instructional stage of classroom instruction (Pollard et al., 2008), and having theoretical knowledge of the template for writing a lesson note is sufficient for PST to write a good lesson note. Hence, the supervision should be directed at both the lesson note and the classroom instruction.

The sixth written feedback (SN6) in **Table 3** was provided by the college supervisor to a PST that is teaching the periodic table during practicum. The feedback addressed both instructional planning and classroom presentation. Although, this supervisor's feedback did not specify the exact aspect of the classroom delivery or pre-instructional planning of PST, which the feedback intends to affirm or correct. The supervisor is also an expert in the English language with a doctoral degree. For the quantitative count, there were 113 written feedbacks. Out of 113, 16 had no direction, 84 focused on pedagogical knowledge while 13 are related to PCK.

This is not an attempt to advance the superiority of written feedback addressing PCK, because feedback focusing on PK were offered based on the observed lesson. In the assessment of the supervisors the PK related feedback will meet the learning needs of PST as regards practice and knowledge of teaching. Nevertheless, PCK makes the difference between the knowledge and practice of PST and those of the other disciplines. Hence the number of written feedbacks addressing PCK seems to be very low. Among many possible explanations for the abundance of PK related written feedback is that it is knowledge base, which most of the supervisors wish to affirm or correct based on the assessment of their PST's classroom delivery. It is also possible that it is easier to offer PK related feedback to PST. However, a perspective this study also looked at was the discipline of the supervisor offering the different type of written feedback. It was observed that 89 PK and 16 unspecifying written feedbacks were offered by majorly by supervisors who are not in the science discipline. All the supervisors who provided PCK related written feedback had science background. The inference that can be easily drawn is that having science background predisposes the supervisor to offer PCK related written feedback. On the other hand, those without such background are likely to provide written feedback that are related PK and those that do not specify any teaching knowledge.

### **PCK's Domains and Components Addressed by Supervisors in PCK Related Written Feedback**

PCK related written feedback provided by the supervisor addressed discipline of science in general, subject taught, and specific topic taught (**Appendix A**). The domain and subject specific domains of PCK were more addressed in PCK related written feedback. This means that the most supervisors written feedbacks that addressed PCK focused on how science should be taught generally. On the other hand, those focusing on how subject, and topic should be taught are not very abundant. Example of domain specific written feedback is the feedback addressing how physical science should be taught in **Table 2**. While written feedback III in **Table 2** is an example of topic specific written feedback in which the supervisor affirmed that the experiment set up for separation technique practical was adequate. And the subject specific PCK related feedback addresses how the topic ought to be taught. The feedback II in **Table 2** that addressed how chemical equations should be written is topic specific. It is yet to be established in literature if there is superiority among the three domains of PCK because PST needs all three.

In addition to these, different components of PCK were also addressed by the written feedback. The components addressed in different domain includes: the conceptual teaching strategy, representation, and curricular saliency. They were more corrective written feedback in the area of conceptual teaching strategy; such that the teaching strategy or approach adopted by PST were corrected. The suggestion in **Table 2** on teaching vertical and horizontal lines is an example of such feedback. The representation component of PCK had less feedback related to it and the least is curricular saliency.

The components that were not frequently addressed in the written feedback were curricular saliency, PK of pupils and knowledge of what makes a discipline/subject/topic easy or difficult for learners. These components are not many probably because unlike the other components (conceptual teaching strategy, and representation and analogy), which were prevalently addressed in the written feedback, are not easily enacted and observed in the classroom by PST and supervisor respectively.

### **DISCUSSION**

During the practicum, the reality of the classroom dawned on PST. Hence, the potential of the supervisor's comment to improve PST's PCK is of great value to the supervisor who desires to achieve the core purpose of learning-oriented field assessment (Fazio & Volante, 2011; Parkison, 2008). After TP, the chances that a PST will experience another learning-oriented field assessment is very slim in Nigeria. Hence feedbacks received during TP has lasting impact on practice.

Consequent upon the findings of this study, PCK related written feedback was the least offered type of written feedback by the supervisors. On the other hand, unspecifying written feedback, were more abundant than PCK related ones. This implies that amidst other types of feedback, it is common among PST sampled in this study not to receive PCK related written feedback (corrective or affirming) during TP from the college supervisor. This does not mean that PST do not need written feedback in other teaching knowledge bases such as PK that is abundant in this study. Rather, it is indicating that most of the feedback are likely to promote general pedagogical knowledge or give no specific direction of improvement.

Pedagogical knowledge related feedback would likely improve PST expertise in the principle and strategies of classroom management and organization that are cross-curricular (Shulman, 1987). Hence, PST who acts on such feedback will be able to maximize the quality of instructional time, handle classroom event, teach at a steady pace, maintain clear direction in lessons, have a command of various teaching methods, and knowing when to apply the methods, have knowledge of classroom assessment, structure learning objectives, and adaptively dealing with heterogeneous learning groups classroom (Voss et al., 2011).

This study does not claim the connection between the supervisors' written feedback and PSTs' development of PCK empirically, but it has shown that supervisors provide feedback that are related to PK more than those addressing PCK. Some supervisors also offer written feedback that does not affirm or correct any teaching knowledge or practice. Although, outside the objective of the study it was observed that supervisor who do not have science background consistently offered PK and unspecifying written feedback.

Although the PK related written feedback is the most abundantly offered written feedbacks by supervisors. If PSTs act on PK related written feedback and improves the general pedagogical skill alone cannot make a PST a competent science teacher. Literature abounds on the positive relationship, which exists between the students' achievement in science and science teachers' competence (Gess-Newsome et al., 2010). Yoon and Cha (2016) argued that recruiting and retaining teacher of the highest competence is considered a critical factor in improving and sustaining quality school science education. This calls for the inclusion of feedback that has the potential for developing PSTs' PCK on the part of supervisors. Teachers with such competence (PCK and PK) among other things, can help learners gain an understanding of a specific science content (Gess-Newsome, 1999). PSTs with such feedback will be able to select a suitable teaching method, technique, and analogy for particular content. Equally, they will be able to teach science in a way that the national curriculum demands will be met by the learners without

jeopardizing their ability to do well in the external and internal examination. Equally PSTs will also be able to teach a student to acquire scientific literacy, critical thinking, and problem-solving, where necessary. Given the expected benefits of PCK related feedback, it must be a prominent indicator of quality.

Instead of matching PST to the supervisors according to similar subject specialization of the practice geographically matching supervisors to PSTs is among the factors responsible for PSTs receiving the low amount of PCK related written feedback. Just like a language teacher may not effectively teach science effectively, a supervisor outside PST teaching subject, will not effectively offer PCK related feedback to PST during TP. Since TP is a field oriented learning experience, the criteria for selection of a TP supervisor should go beyond being in the science discipline but being an expert in the subject PST is teaching.

Most of PCK related written feedbacks in this study were skewed towards science discipline. And those focusing on the subject and topic, which the pre-service teacher is teaching specifically were few. In as much there it is not the aim of this study to determine which of the domains of PCK is what PST needed most, this findings will not be rated poor. Nevertheless, in the study of Rollnick and Mavhunga (2016) it was determined that developing topic specific PCK of pre-service physical science teachers in South Africa is beneficial. This is because such PST were able to transfer the principles of topic specific PCK to a new topic in the same subject. The generic nature of science and subject domain of PCK may not make such transfer possible. Therefore, supervisors must provide PCK feedbacks that are directly related to the topic that PST is teaching.

### **Limitation of the Study**

No attempt was made in this study to match the supervisors' oral feedback with their written feedback. Perhaps the oral feedback, which the supervisors offered went in the same or different direction as the written was not ascertained.

### **CONCLUSIONS AND PERSPECTIVES**

This study indicates that the majority of the written feedback of the college supervisor during practicum of PSTs did not address PCK of PSTs. Most of the feedback focused more on the general pedagogy while some addressed no specific teaching knowledge and practice. Most of the supervisor lacked training in both the content and pedagogy in the subject, which PST they are supervising the teachers. While offering feedback the supervisor must bear it in mind that the feedback must address a specific teaching knowledge. For those supervising PSTs, topic-specific PCK related feedback should be given the adequate attention and

consideration, most especially the component related to conceptual teaching strategies.

The deductions made from the findings that showed that the supervisors' written feedbacks are directed more at conceptual teaching strategy and representation components of PCK is instructive. Having established that it may be difficult for the supervisors to assess other three components given the short time used for the assessment of PST's classroom delivery. However it can be said that the supervisors should look out for conceptual teaching strategies of PST if they cannot touch any other. The indices of the component include but not limited to determining if the teaching strategy clearly explain the big idea of the topic and if the strategy will make the learners to think (Rollnick & Mavhunga, 2016).

**Author contributions:** All authors have sufficiently contributed to the study and agreed with the results and conclusions.

**Funding:** No funding source is reported for this study.

**Ethical statement:** Authors stated that the research sought the approval of the College Research Ethical Committee to make use of PST TP's lesson note. Afterward, PST who submitted their TP lesson notes were given a consent form, which they returned. They were assured that the details of their identity will not be disclosed. Similarly, the details of the supervisors who offered the feedback in the lesson notes were kept confidential.

**Declaration of interest:** No conflict of interest is declared by authors.

**Data sharing statement:** Data supporting the findings and conclusions are available upon request from the corresponding author.

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**APPENDIX A**

**Table A1.** Framework for interpretation of written feedback that is centered on PCK

SN	Supervisor discipline or feedback number	PST's teaching subject/topic	PCK related feedback of supervisors			
			PCK component	Field addressed in feedback		
				General science	Specific subject	Topic specific
1	Biology/four	Biology	Conceptual teaching strategies		1	
			Students' prior knowledge			
			Curricular saliency		2	1
			Understanding what makes topic easy or difficult to understand Representation including analogies			
2	Social studies/nine	Biology	Conceptual teaching strategies	1		
			Students' prior knowledge	2		
			Curricular saliency			
			understanding what makes topic easy or difficult to understand Representation including analogies			
3	Chemistry/13	Chemistry	Conceptual teaching strategies	3		2
			Students' prior knowledge			
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand Representation including analogies		3	3
4	Chemistry/19	Chemistry	Conceptual teaching strategies		4	
			Students' prior knowledge			
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand Representation including analogies		5	
5	Chemistry/20	Chemistry	Conceptual teaching strategies	4		
			Students' prior knowledge			
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand Representation including analogies	5		
6	Health education/25	Health Education	Conceptual teaching strategies		6	
			Students' prior knowledge			4
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand Representation including analogies			
7	Biology/26	Physics	Conceptual teaching strategies	6		
			Students' prior knowledge	7		
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand Representation including analogies			
8	Chemistry/26	Physics	Conceptual teaching strategies	8	7	
			Students' prior knowledge			5
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand Representation including analogies			6
9	Health education/29	Chemistry	Conceptual teaching strategies		8	
			Students' prior knowledge			
			Curricular saliency	9		
			Understanding what makes topic easy or difficult to understand Representation including analogies			

**Table A1 (Continued).** Framework for interpretation of written feedback that is centered on PCK

SN	Supervisor discipline or feedback number	PST's teaching subject/topic	PCK related feedback of supervisors			
			PCK component	Field addressed in feedback		
				General science	Specific subject	Topic specific
10	Biologist/31	Chemistry	Conceptual teaching strategies	10		
			Students' prior knowledge	11		
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand			
Representation including analogies						
11	Chemistry/32	Chemistry	Conceptual teaching strategies	12		
			Students' prior knowledge			
			Curricular saliency			
			Understanding what makes topic easy or difficult to understand			7
Representation including analogies			13			
12	Biochemistry/33	Chemistry	Conceptual teaching strategies		9	
			Students' prior knowledge			
			Curricular saliency	14		8
			Understanding what makes topic easy or difficult to understand			
Representation including analogies						

<https://www.ejmste.com>