

Developing Technology Pedagogical and Content Knowledge in Pre-Service Accounting Teachers with the Use of Audio-Visuals: A Ghanaian Perspective

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How to cite this paper: Darkwa, B. F., & Agyei, D. D. (2021). Developing Technology Pedagogical and Content Knowledge in Pre-Service Accounting Teachers with the Use of Audio-Visuals: A Ghanaian Perspective. *Open Journal of Social Sciences*, 9, 431-451.

<https://doi.org/10.4236/jss.2021.97031>

Received: June 7, 2021

Accepted: July 25, 2021

Published: July 28, 2021

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Abstract

The paper focused on how eight pre-service teachers developed their TPACK to integrate audio-visual materials in teaching concepts in Accounting in Senior High Schools in Ghana. Sequential multiple case study design was employed to observe two cohorts of four pre-service teachers who worked in two phases of professional development to design and enact Accounting audio-visual supported lessons. Data for the study were collected through observation, interview, lesson documents and questionnaires. Content and thematic analysis procedures were used to analyse the qualitative data, whilst means and standard deviation were used to analyse the quantitative data. It emerged from the results that the pre-service teachers developed their TPACK significantly through the professional development arrangement. The study also revealed that the teachers themselves developed knowledge of their subject matter which they teach much better when they designed and prepared to enact the audio-visual lessons. One limiting factor however, that impeded their proficient TPACK development, was lack of ICT resources. Consequently, the study advocates that key stakeholders in education must put priority on the provision of ICT facilities in Ghanaian schools; easy access to ICT resources will certainly contribute to teachers' use of ICT innovations in schools.

Keywords

Audio-Visuals, Professional Development, TPACK, Pre-Service Accounting Teachers, Accounting Education

1. Introduction

As new learning concepts have evolved (OECD, 2003; 2008), it is imperative for Accounting teachers to use new approaches to enhance students learning in the classroom rather than to provide only knowledge and skills. The introduction of innovative technologies in teaching has provided a platform for teachers to change the way they teach and also facilitate the learning process (Robinson & Tang, 2005). However, these innovative strategies require teachers to be abreast with how to use new technologies to facilitate the teaching and learning process to make learning more meaningful for students. Teachers have a repertoire of different strategies and techniques which they can use to create the right condition for learning (Hopkins, 2002). According to Oyekan (2000), accounting teachers can use a variety of teaching methods since there is no one generally accepted method of teaching Accounting. Therefore, Accounting teachers are expected to use various strategies in the teaching of Accounting at the Senior High School.

Teaching strategies used by teachers in the classroom, in most instances, determine the success and quality of students' learning. In recent times, a variety of ICT tools can be used to enhance the delivery of instruction in the classroom as well as providing opportunities for students to share ideas. Studies (Fu, 2013; Koh, 2013; Haddad, 2003) have indicated that ICT can change the way teachers teach. Using ICT in teaching has the tendency of promoting the use of more student-centred approaches to instruction as well as developing higher-order skills. According to Majumdar (2002), understanding the changing role of teachers from instructors to facilitators, teacher-led instruction to learner-centred instruction is the key to the successful implementation of pedagogy-technology integration for teacher development.

The major emphasis of integrating ICT in teaching should be on its potential to improve learning, engage learners, and also promote collaboration among learners in the classroom (Zhu, 2003). Studies about ICT infusion in teaching have revealed that, when teachers employ technology during an instructional session, it provides opportunities for students to share learning resources and spaces and also enhances critical thinking and problem-solving skills of students (Allan, 2007; Fu, 2013; Koh, 2013). These assertions about ICT infusion in teaching suggest that utilising ICT to improve teaching and learning should be of utmost concern to teachers in performing their role as creators of pedagogical environments. This has implications on how teachers should be prepared to develop their TPACK in teaching with ICT.

In Ghana, pre-service Accounting teachers (PSATs) are student-teachers in universities who are being prepared to become professional Accounting teachers in Senior High Schools. As part of their preparations, they are expected to develop innovative ways of enhancing the teaching of concepts in the classroom. This paper, therefore, explores how PSATs in Ghana developed their TPACK in the designing and enactment of ICT based materials in teaching concepts in Ac-

counting. The specific ICT tool used in this study was audio-visual resources from the internet. This is so because given the context of Ghana and many similar such contexts these audio-visual resources are readily available, user friendly and also have the potential to enhance Accounting teaching (Agyei & Voogt, 2011a, 2011b).

Potentials of audio-visual materials in teaching

The teaching profession is filled with countless opportunities to enrich the academic lives of students (Mohanty, 2001). Teachers therefore have varied ways of making seemingly difficult concepts in a lesson more easily for students' assimilation during teaching and learning process. Generally, while some concepts in a lesson may be considered easy for students to understand, others may require them to think critically and creatively before important learning objectives can be met. Using audio-visual aids in teaching is one way to enhance lesson plans and give students additional ways to process subject information (Kunari, 2006). Teachers can use pictures and videos with sound in their lessons to demonstrate a particular concept to students. The images, animations and videos with sound in teaching have the capacity of sticking in students minds for a longer period of time. Audio-visual aids are those instructional devices that are used in the classroom to encourage learning and make it easier and interesting (Lari, 2014). "Any device which by sight and sound increase the individuals' experience beyond that acquired through reading is described as an audio-visual aid" (Singh, 2005).

According to Rather (2004), audio-visual materials include a film strip, projectors, radio and television. Audio-visual materials present both visuals and sound which appeal to two senses (eyes & ears) and therefore have the potential to increase individuals' experience through sight and hearing at the same time. According to Anzaku (2011), the term audio-visual materials refer to those instructional materials that may be used to convey meaning without complete dependence upon verbal symbols or language. This implies that audio-visuals can include materials that can convey sound (e.g. radio, speakers and microphones) and visuals that can be seen (e.g. projectors, pictures and videos). Teachers can present information in the classroom through the use of these materials to enhance students understanding through watching and hearing.

The use of audio-visual materials in a lesson stimulates thinking and understanding (Kishor, 2003). Studies (Saima, Qadir, & Shazia, 2011; Rautrao, 2012; Ashaver, 2013) have proved that approximately 83% of human learning occurs visually, and the remaining 17% through the other senses 11% through hearing, 3.5% through smell, 1% through taste, and 1.5% through touch. The famous Chinese philosopher, Confucius's quote (as cited in Awayiga, Onumah, & Tsamenyi, 2010) that "I hear and I forget; I see, and I remember; I do, and I understand" underscore the importance of audio-visual materials in a lesson. Audio-visual aids provide learners with realistic experiences, which capture their attention through the visual-auditory senses (Jain, 2004). Teachers have the responsibility to make learning as enjoyable as possible, which is hard to carry out without having the communication abilities required by every teacher. In order

to avoid any breaking of communication between the teacher and the student, it is most preferable to use audio-visual aids (Rao & Jyoti, 2012).

In this study, we conceptualized audio-visuals to include ICT resources such as videos, images and animations which could be used to make the learning experience more concrete, more realistic and more dynamic and also arouse the interest of learners as well as help teachers to explain concepts in a lesson easily. We hypothesized that once pre-service teachers involved in the study explore the opportunities of using these materials to design and enact lessons, the tendency to develop their technological pedagogical content knowledge needed to integrate ICT effectively in teaching will be high.

Teachers' Knowledge for Technology Integration

According to Mishra and Koehler (2006), at the heart of every good teaching with technology are the three core elements: technology, pedagogy and content. Teachers are expected to understand the relationship among these elements and how they can use it to their advantage. Effective use of technology in teaching requires the development of special kind of knowledge which (Mishra & Koehler 2006) referred to as Technological Pedagogical and Content Knowledge (TPACK). TPACK outlines the knowledge teachers need in order to efficiently employ appropriate technology as part of their pedagogy to enhance the teaching and learning process. According to Mishra and Koehler (2006), TPACK goes beyond the three individual components of content, pedagogy and technology and represents a class of knowledge that is central to teachers' work with technology.

They argued that it is not enough for teachers to knowledge of content, pedagogy and technology but more importantly, an understanding of the interrelationship among the three types of knowledge. This implies that for effective integration of technology in teaching, teachers are expected to know about: what pedagogy is suitable for which content, how technology and content are related and how pedagogical strategies can be applied to the use of technology. There is a dynamic equilibrium among the three elements which is required for effective technology integration in the classroom (Mishra & Koehler 2006). **Figure 1** presents the elements of the TPACK framework. The elements are:

Technology knowledge (TK): Technology knowledge refers to the knowledge about various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as the internet, digital video, interactive whiteboards, and software programs;

Content knowledge (CK): Content knowledge is the "knowledge about actual subject matter that is to be learned or taught" (Mishra & Koehler, 2006: p. 1026). Teachers must know about the content they teach and how the nature of knowledge is different for various content areas;

Pedagogical knowledge (PK): Pedagogical knowledge refers to the methods and processes of teaching and includes knowledge in classroom management, assessment, lesson plan development, and student learning;

Pedagogical content knowledge (PCK): Pedagogical content knowledge refers to the content knowledge that deals with the teaching process (Shulman, 1986).

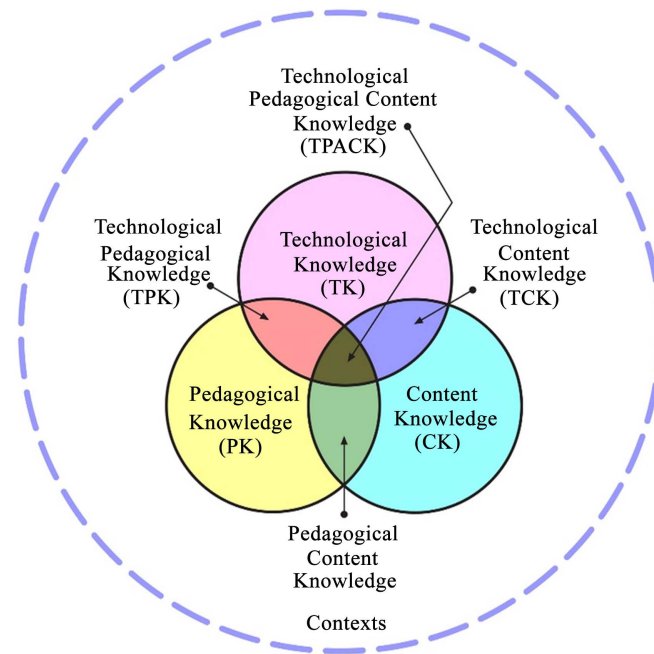


Figure 1. Elements of TPACK framework (Mishra & Koehler 2006).

Pedagogical content knowledge is different for various content areas, as it blends both content and pedagogy, aiming to develop better teaching practices in the content areas;

Technological content knowledge (TCK): Technological content knowledge refers to how technology can create new representations for specific content. It suggests that teachers understand that they can change the way learners practice and understand concepts within a particular content area by using a particular technology;

Technological pedagogical knowledge (TPK): Technological pedagogical knowledge refers to how various technologies can be used in teaching and to understand that using technology may change the way teachers teach; and

Technological pedagogical content knowledge (TPACK): Technological pedagogical content knowledge refers to the knowledge required by teachers for integrating technology into their teaching in any content area.

According to Schmidt et al., (2009), teachers should have an intuitive understanding of the complex interplay between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies. The underlying belief is that teachers have to be prepared to be able to incorporate technology in their classrooms successfully; merely knowing how to use technology is not the same as knowing how to teach with it (Mishra & Koehler, 2006). Accordingly, the study adopted Mishra and Koehler (2006) model as a guiding framework to developing teachers' knowledge needed for the pre-service teachers to effectively integrate technology in teaching. In the following section, we conceptualized how the TPACK framework was used in this study.

Towards the Conceptual Framework of the Study

Figure 2 demonstrates how the TPACK framework by **Mishra and Koehler (2006)** has been conceptualized in this study. As shown in the figure, content knowledge was accounting which was the pre-service teachers' teaching area. The technology used in the study was audio-visual, and general pedagogy was employed. The study hypothesized that if teachers have good knowledge of their subject matter (Accounting) and pedagogical strategies and knowledge in the use of audio-visu-als, they can effectively integrate ICT in teaching. For the purpose of the study, the following conceptualizations were made with respect to **Mishra and Koehler (2006)** TPACK components. *Technological Knowledge (TK)* referred to the knowledge about audio-visual materials the pre-service teachers used in the classroom. *Content Knowledge (CK)* referred to the knowledge about Accounting for which the pre-service teachers were expected to impart to students to bring about positive change in the behavior of students.

This required mastery of the subject matter by the teachers to explain clearly and apply theories, principles and concepts that involved Accounting. *Pedagogical Knowledge (PK)* was the teaching strategies employed by the pre-service teachers in teaching which included classroom management strategies and assessment procedures. *Pedagogical Content Knowledge (PCK)* referred to the blend of appropriate strategies that pre-service teachers employed in teaching accounting to develop better teaching practices. *Technological Content Knowledge (TCK)* referred to the knowledge of how audio-visu-als were used to enhance students' understanding of Accounting and *Technological Pedagogical Knowledge (TPK)* the knowledge of how audio-visu-als influenced the strategies used in teaching to enhance students' outcomes. *Technological Pedagogical Content Knowledge (TPACK)* was the knowledge required by the pre-service teachers to understand the interplay between the use of audio-visu-als, their teaching strategies and the Accounting subject matter. It included the ability of the teachers to select and use appropriate audio-visual materials to teach concepts in Accounting.

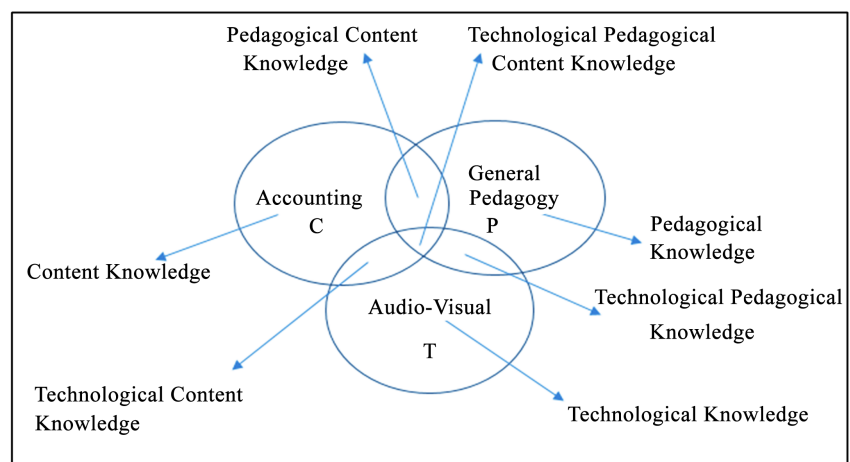


Figure 2. Conceptual Framework for Study (Adopted from **Mishra & Koehler, 2006**).

Based on the framework, a Professional Development Arrangement (PDA) was organized for the pre-service teachers. The purpose of the PDA was to provide opportunities and support for the teachers to collaboratively design and use the ICT-supported lesson teaching materials to develop their TPACK.

Professional Development Arrangement

The PDA was organised for two cohorts of four (4) PSATs in two phases. TPACK Self-Assessment questionnaire was administered to the pre-service teachers before and after the training to track the development of knowledge and skills by pre-service teachers in teaching with ICT. The professional development arrangement was in three (3) stages: 1) an introductory workshop for the PSATs of the study, 2) design of ICT-supported lessons by PSATs in groups, and 3) implementation of lessons designed by the PSATs. The introductory workshop lasted for one week in each phase and prepared the pre-service teachers by giving them the theoretical foundation/concepts and practical skills. Based on the experience from the workshop, the first cohorts of PSATs (phase 1) were put into groups of two; group 1 (G1TR1; G1TR2) and group 2 (G2TR1; G2TR2). They were tasked to design their own lessons, which included (lesson plans and students' worksheet) that integrate audio-visual materials in teaching Accounting. Each group was given a maximum of one week to design their ICT-based lesson. Two lessons were developed on the topics; Bank Reconciliation Statement (BRS) and Value Added Tax (VAT) by group 1 (G1TR1; G1TR2) and group 2 (G2TR1; G2TR2), respectively.

One member from each group taught with their designed lessons among themselves in a micro-teaching session. At the end of the micro-teaching, a thorough evaluation of the lessons and the teaching process was conducted. Based on feedback received from the micro-teaching try-outs, the teams revised their lessons and taught the lessons again in a second micro-teaching try-out by the second members of each group, respectively. The first professional development arrangement (PDA) outcome for the first cohorts of PSATs informed phase 2 of the PDA. In phase 2 of the PDA, the second cohorts of PSATs were also put into two groups; group 3 (G3TR1; G3TR2) and group 4 (G4TR1; G4TR2) and were also tasked to design ICT based lessons. One member from each group taught with their designed lessons among thirty-one (31) student teachers (who were their peers) in a designed classroom situation during an on-campus teaching practice session which was part of their programme. The groups used the feedback received from their peers to modify their lessons, and the remaining members, one from each group, taught with their modified lessons in a real classroom in Senior High School.

Research Question and Research Design

Data collected during the PDA was employed in addressing the question of the study. The main research question that guided the study was: To what extent did the Accounting pre-service teachers' TPACK in designing and implementing technology-enhanced lessons develop and impact on their experiences? A sequential multiple case study design, which involved two cohorts of four (4)

pre-service teachers in two different phases was employed in the study. The sequential multiple case study was considered appropriate as it learned itself to the provision of more extensive description of a phenomenon (Gerring, 2007). Secondly, the design was deemed appropriate for the study because data for the second cohort (case) of pre-service teachers were informed by the outcome of the first cohort (case). Purposive sampling technique was employed to select eight (8) pre-service teachers who were in the third year Bachelor of Education Accounting programme at the University of Cape coast. These participants were selected based on the criteria that they had been taught “a course on methods of teaching Accounting” in their third year. They were also ready to undertake their first phase of teaching internship, an on-campus teaching practice in which they teach their peers. Thus, these participants were the best participants to purposefully inform an understanding of the research problem, and central phenomenon, which focused on tracking pre-service teachers developed TPACK.

2. Methods

Participants

Eight pre-service Accounting teachers (experimental teachers) and their student peers (31) (student-teachers) participated in the study. The pre-service teachers were made up of three females and five males, whilst the student-teachers who volunteered to be part of the study were 19 males and 12 females. The average age of both participants was 24 years. Both groups of participants were in their third year of the teacher education (B.Ed. Accounting) programme at the University of Cape Coast. The B.Ed. (Accounting) is a 4-year programme that prepares students to teach Accounting at Senior High School when they graduate. In the study, the pre-service teachers worked in groups to design and enact audio-visual supported lessons for Accounting. The pre-service teachers and the student-teachers have not had any experience in a technology-supported lesson as part of their training in the University. The designed lessons were implemented in peer teaching sessions as well as in real SHS classrooms. As part of the study, the PSATs taught SHS 2 students in two separate Senior High Schools (School A and School B) in the Cape Coast Metropolis. The students in School A and School B who participated in the study were 19 and 22, respectively. In all, 80 participants were involved in the study.

Research instruments

Pre-service teachers TPACK questionnaire

TPACK self-assessment questionnaire (adapted from Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009) was used to collect data for the study. This was used to track the change in PSATs developed ICT-oriented knowledge. The questionnaire included items that addressed the pre-service teachers’ self-efficacy of their TPACK on a five-point Likert scale format (from 5-strongly agree to 1-strongly disagree). Cronbach’s alpha reliability estimates of this instrument

range from 0.75 to 0.93 (Schmidt et al., 2009). **Table 1** presents sample question for each TPACK knowledge type.

The questionnaire comprised 44 items grouped under seven (7) constructs, namely: “Technology Knowledge (TK), Pedagogy Knowledge (PK), Content Knowledge (CK), Pedagogical Content Knowledge (PCK), Technology Content Knowledge (TCK), Technology Pedagogical Knowledge (TPK) and Technological Pedagogical and Content Knowledge (TPACK)”. In particular, TK = 7, PK = 7, CK = 5, PCK = 4, TCK = 5, TPK = 9, and TPACK = 8 items. The questionnaire was given to the PSATs before and after the professional development training organised for the pre-service teachers. This helped to determine the pre-service teachers’ developed knowledge (TPACK) in relation to ICT audio-visual integration.

Interview guide

Interview data were collected after each session of micro-teaching and peer-teaching. The interview focused on PSATs experiences and opinions of the audio-visual based lesson from the designing and implementation stage. To ensure the content validity of the questions on the interview guide, the first draft of the guide was shown to two experts in Accounting and ICT education. The suggestions from the experts were used to improve the quality of the items in the interview guide. Internal validity of PSATs’ interviews was ensured through credibility, where the researcher offered the PSATs opportunity to add further information to what they had given earlier on.

PSATs lesson artefacts

Lesson artefacts designed by the pre-service teachers were also used as a source of data for the study. Thus, four lesson documents developed and implemented by the teams served as sources for data. These lesson artefacts were examined to ascertain the extent to which the pre-service teachers developed their TPACK in their designed lesson plan document. Interrater reliability of the lesson plans was calculated.

Observation (Researcher’s logbook)

Table 1. Sample question for each TPACK knowledge type constructs.

Knowledge Type	Sample Question For Each Knowledge Type
TK	I can embed videos in a PowerPoint presentation
PK	I can adapt my teaching style to different learners.
CK	I have sufficient understanding of concepts and principles within accounting.
PCK	I know instructional strategies that are suitable for accounting concepts.
TCK	I know about audio-visuials (e.g. images, YouTube videos) that I can use to enhance learning of accounting.
TPK	I can use PowerPoint presentations to enhance teaching
TPACK	I can use PowerPoint presentations to enhance strategies for teaching accounting

The researchers' logbook was used to maintain a record of activities and events occurring during the classroom implementation of the audio-visual supported lessons by the PSATs.

Data analyses procedure

A combination of qualitative and quantitative methods of analyses was employed due to the use of different instruments used for data collection. Descriptive statistics specifically means and standard deviations, were used to analyse the quantitative data from the TPACK self-assessment questionnaire. Interview data were audiotaped and transcribed using pattern coding techniques (Miles & Huberman, 1994). Two raters coded the interview data using a sample of two interviews; the interrater reliability (Cohen's K) was $K = 0.90$. Content analysis in which codes were generated based on the categories was done for the lesson documents. The interrater reliability (Cohen's K) assessed for the lesson documents was $K = 0.94$. The information recorded in the researcher's logbook was analysed qualitatively using data techniques (Miles & Huberman, 1994).

3. Results

Pre-service teachers developed TPACK in enacting audio-visual supported lessons

A major question that needed to be answered in the study was how pre-service teachers developed their TPACK in designing and enacting audio-visual-based lessons. In order to address the question, both quantitative and qualitative data were analyzed to track the development of PSATs TPACK in enacting audio-visual supported lessons. It emerged that the PSATs TPACK developed and this was reflected through the lesson plan documents developed, interviews, classroom observations and TPACK self-assessment questionnaire the teachers responded to.

For example, analyses of the lesson plan documents which were designed by group 4 (G4TR1; G4TR2) and group 3 (G3TR1; G3TR2) for teaching the topics: Partnership accounts and Depreciation of non-current assets respectively showed evidence (see **Figure 3** and **Figure 4**) of how the pre-service teachers developed their TPACK in the designing of their lesson plans. The evidence gathered from the lesson plan documents prepared on the topic, Partnership accounts by PSATs in group 4 (G4TR1; G4TR2) showed that the teachers planned to use their knowledge of the affordances of technology to stimulate learners' thinking abilities and enhance their understanding of concepts in the lesson (*TCK*). This assertion was made based on the fact that from the analyses of the lesson plan documents, the PSATs demonstrated the kinds of audio-visual materials (*TK*) and at what point they would be used in the lesson (*TPK*).

This was further confirmed when the lessons were implemented. It was observed that the PSATs made use of their developed TPACK to: 1) guide learners in acquiring knowledge through the use of videos, animations and images of concepts in the topic (i.e. making use of their *TK*), 2) represent concepts associated to stimulate learners' thinking abilities and enhance their understanding

<p>Lesson Development (new knowledge, reinforcements, and reflections) (80 minutes)</p> <p>TPACK</p>	<ul style="list-style-type: none"> Through power-point presentation, the teacher shows downloaded videos and images to students for them to watch. (TPK) <p>Activity 2 A: Partnership Business Trading, Profit and Loss and Appropriation Account (20 minutes) (TK)</p> <ul style="list-style-type: none"> Using the Jigsaw method (where each member in a group has a home group and a learning group). teacher groups students into groups of four and asks Students to prepare Trading, Profit and Loss Account from a given sample of question. (see Activity 2A) (TPCK) After activity 2, teacher asks students to break into their home group to share their solution (from learning groups) with their colleagues for discussion. Using Microsoft excel, the teacher solves the trading, profit and loss account with students. (TCK) 	<ul style="list-style-type: none"> Students listen and watch the videos and images and then write down the key partnership concepts in the activity, as teacher provides a summary of the activity for revision purposes. Students apply their prior knowledge from the preparation of final account of a sole trader on activity sheet in their learning groups (see activity 2A) Students break into their respective home groups and share their ideas by discussing their solution to the questions on the activity sheet under activity 2 with their colleagues.
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Figure 3. Excerpt of lesson plan documents by PSATs' in Group 4.


<ul style="list-style-type: none"> The picture below will be used to demonstrate depletion of land to students through power point presentation 	<ul style="list-style-type: none"> Students will listen and watch the image and answer some question
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Figure 4. Excerpt from group 3 lesson plan.

of concepts in Accounting (i.e. making use of their *TCK*), and 3) facilitate their way of teaching in an interactive manner (i.e. making use of their *TPK*).

Similarly, an analysis of the lesson on Depreciation of Non-Current Assets (prepared by group 3) showed similar results. The lesson plan documents showed that teachers had indicated the videos and animations (*TK*) that would be employed in their lesson (*TPK*). These videos and animations had the potential to promote understanding of the topic (*CK*) and make it more interesting and realistic in the classroom (*TCK*). They demonstrated in their lesson docu-

ments how they would use videos and other images to explain “depletion of non-current assets,” (*TPACK*) a concept that is normally taught in abstraction in the traditional Accounting classroom. An excerpt of the lesson document is shown in **Figure 4**.

Observation during the implementation of the lesson revealed that the teachers made use of their developed *TPACK* in a way that enhanced their teaching strategies, as depicted in the lesson document. During the lesson delivery, the teacher projected images (see **Figure 4**) through an interactive and exploratory approach (*TK*) to facilitate the learners’ understanding on the concept of “depleted” and “used land” (*TCK*) in a manner that demonstrated the *PSAT* understanding of the affordances of the technology (*TPACK*). Through the use of audio-visual materials, the pre-service teachers were able to connect the concepts in the topics to the real-life experience for the students to appreciate the connectedness between what they were learning in the classroom and what happens in the real-world situation. For example, the teachers were able to use the videos and images to illustrate how assets such as land deplete as a result of some human activities observed in various parts of the country. **Figure 5** is an example of video/picture of some of these activities that were used in the lesson.

The *PSATs* also confirmed during an interview session after the implementation of their lessons that their teaching had improved because of their developed *TPACK*. According to the *PSATs*, the integration of audio-visuals in the teaching enhanced their teaching approaches in the sense that most of the concepts in Accounting, for example, Depreciation of non-current assets which they would have taught in abstraction in a typical traditional classroom was easily taught and understood through the use of videos, animations and images. According to them, the audio-visuals helped them to explain the concepts well for learners to improve their understanding of the concepts in the lessons taught.

The following are some of the responses given by the pre-service teachers in response to the question: Was the integration of the audio-visuals helpful in teaching Accounting in this lesson?



Figure 5. Excerpts of images used in the lesson plan documents by *PSATs* in group 3.

G3TR1: *It was very helpful and made the lesson interesting. I was able to use videos, animations and pictures of mining sites in explaining depletion (assets of wasting character) to students in the lesson. The feedback from the students indicated to me that the concept was well understood by the students. Initially, I had no idea of how to embed videos and hyperlinks in a PowerPoint presentation but through the work shop, now I have mastered how to do them easily. {CK, TK, TPACK, TCK ...}*

G4TR2: *Yes, it was indeed helpful to me during the preparation of my lesson plan because I was able to download readily available videos and images I needed from the internet to illustrate to students' reasons why people enter into a partnership business. Before the study, I did not know how to download videos and animations from YouTube. However, the training helped me and now I can download videos from YouTube. Wedding pictures of couples and videos of friends working together on a task were some of the visuals I used in explaining the concept of partnership to student. {PK, TK, TCK, TPACK ...}*

G3TR2: *Yes, because through the use of the audio-visual materials, I was able to explain the concept of Depreciation much better. Again, I was able to link the concept of Depreciation to real-life situations. For example, the use of images of "galamsey" sites in Ghana helped the students to understand the concept better. {TPK, TCK, TPACK, TK ...}*

The responses show evidences of various elements of TPACK reported by the PSATs; an indication that the PSATs developed their TPACK not only during their planning to teach but also during the actual implementation of their lesson.

Quantitative data collected before and after PDA also corroborated the results of the qualitative data. The purpose of the TPACK self-assessment questionnaire was to track the PSATs TPACK knowledge before and after the PDA to ascertain the extent of their TPACK in enacting audio-visual supported lessons. **Table 2** presents the mean scores for pre and post TPACK self-assessment for the first cohorts of pre-service teachers who participated in phase 1 of the study.

Generally, the results revealed an improvement in all the TPACK components. This is because the mean scores for the PSATs TPACK self-assessment

Table 2. TPACK self-assessment (before and after) PDT for phase 1.

Dimension	PRE-PDT		POST-PDT		Gains
	M	SD	M	SD	
TK	2.71	0.47	4.82	0.07	2.11
PK	3.82	0.51	4.89	0.21	1.07
CK	3.50	0.87	4.70	0.35	1.20
PCK	3.38	0.63	4.50	0.29	1.12
TCK	2.40	0.85	5.00	0.00	2.60
TPK	3.28	0.41	4.91	0.12	1.63
TPACK	2.69	0.77	4.88	0.14	2.19

before the PDA was lower than the mean scores after the PDA. For example, for the first cohort of PSATs, it is obvious from **Table 2** that the technology-related components recorded the highest gains TCK (Gain = 2.60) first, followed by TPACK (Gain = 2.19) and then TK (Gain = 2.11). The second cohort of pre-service teachers' TPACK knowledge was also tracked before and after the PDA to ascertain their developed TPACK. **Table 3** presents the mean scores for pre and post TPACK self-assessment for the second cohort of pre-service teachers who were involved in phase 2 of the study.

Similarly, **Table 3** reiterates improvement in all the TPACK self-assessment for the second cohort of pre-service teachers. For example, before the PDA, the pre-service teachers indicated that they had less or no knowledge in relation to TCK (M = 2.20, SD = 0.86) and PCK (M = 2.94, SD = 0.40). Post-PDA, however, revealed that pre-service teachers seem to have improved in all dimensions relating to TPACK. For instance, with CK (M = 4.75, SD = 0.50), an increment of 1.15 points from the Pre-PDT mean with a higher standard deviation. Also, TCK and PCK recorded mean values of 4.70, (SD = 0.35) and 4.75, (SD = 0.50) respectively. The evidence from **Table 2** and **Table 3** also revealed that both first and second cohorts PSATs seemed to have reported low knowledge levels especially for all the TPACK components before the PDA apart from CK and PK. The results seem to suggest that the PSATs were knowledgeable about their content (CK) and pedagogy (PK); this could be as a result of the fact that the PSATs were very particular about content and pedagogy because of their on-campus teaching practice exercise, which was ongoing during the time of the study. This notwithstanding, the results seem to suggest that the PSAT gained a deeper understanding of the CK after working with audio-visuals to design and enact ICT-supported lessons themselves in spite of their initial high CK levels. This has been further explored in the following section.

Pre-service teachers' improved content knowledge in their subject matter

Another major finding of this study was that the PSATs developed their content (i.e. Subject matter) much better despite their initial high CK levels. Analyses of the lesson artefacts (lesson plan, activity sheet and presentation slides)

Table 3. TPACK self-assessment (before and after) PDT for phase 2.

Dimension	PRE-PDT		POST-PDT		Gains
	Means	SD	Means	SD	
TK	3.07	0.34	4.86	0.20	1.79
PK	3.32	0.84	4.82	0.18	1.50
CK	3.60	0.37	4.75	0.50	1.15
PCK	2.94	0.40	4.75	0.50	1.81
TCK	2.20	0.86	4.70	0.35	2.50
TPK	3.28	0.45	4.90	0.24	1.62
TPACK	3.05	0.51	4.93	0.13	1.88

revealed that the pre-service teachers did not only develop their TPACK but also obtained improved content knowledge of their subject matter significantly. This assertion was made on the basis of two main criteria that were used to measure the pre-service teachers' content knowledge (CK) of their subject matter. The first criterion was the quality of the information provided in the lesson plan documents, and the second was the quality of delivery (i.e. clarity in explanation of concepts) during the implementation of the lessons. The information presented in the lesson artefacts attests to the fact that the pre-service teachers improved their content knowledge (CK) of their subject matter. **Figure 6** presents aspects of the information provided in the presentation slides of the audio-visual lesson design by group 3 on the topic: Depreciation of Non-Current Assets.

The excerpt illustrates an image and video of how the PSATs intend to explain some assets (e.g. the furniture, vehicle and computer as depicted in the picture) of business organizations that can depreciate as a result of continuous usage in business in generating income.

Observation during the implementation revealed that they were able to demonstrate to students that vehicles, furniture, computers, plants and machines (as depicted in **Figure 6**) are some of the assets that can be used for more than one Accounting year in the business (non-current or fixed assets). Again, it was observed that, the PSATs were able to use videos in their lessons to demonstrate to students how the Ghanaian Currency (Cedi) depreciates against the US dollar for the students to have a better appreciation of the concept of Depreciation. Specifically, they played a video in the presentation of the lesson, which portrayed to the students how the US dollar was rising whilst the Ghanaian Currency (Cedi) declined with an arrow showing the reduction in the Cedi. The clarity in their expression and their ability to handle students' questions all proved that their content knowledge (CK) improved during the development and implementation of the audio visual-based lessons.

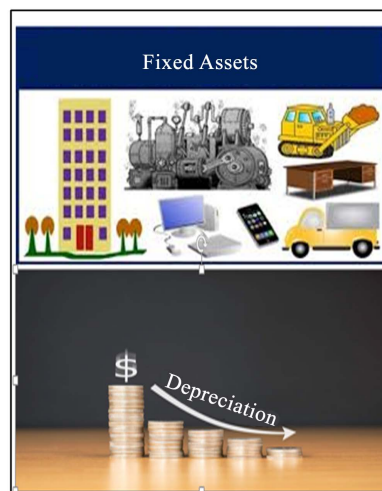


Figure 6. Excerpt of presentation slides from the lesson plan by group 3.

The pre-service teachers also confirmed during interview sessions after the implementation of their lessons that their content knowledge (CK) improved through the designing and enacting of the audio-visual supported lessons. For example, some of the pre-service teachers disclosed in the interview that they had personally benefited a lot because their involvement in the study has helped them better understand some concepts in Accounting that they had difficulty with prior to the study. Some of the pre-service teachers indicated that, before the PDA, they had difficulties explaining concepts such as value addition in the computation of Value Added Tax (VAT), input Tax and output Tax in the production-distribution chain and depletion of land. However, they disclosed during the interview that the experience from the PDA, in which they designed and implemented audio-visual based lessons had a positive impact on them and has enhanced their understanding of the concepts they found difficult before the programme. The following were some of the pre-service teachers' remarks after the implementation of the audio-visual supported lessons.

The following responses were in respect to the question: What general comment can you make about using audio-visuals in teaching Accounting?

G1TR1: *In fact, prior to this training, I was having difficulty in understanding the concept of depletion in Accounting for Depreciation. However, after the workshop and the lesson development sessions, I have obtained an improved understanding of the concept, and I can now explain it better to students with realistic illustrations.*

G2TR1: *I have learnt a lot of new ideas from this study, and it will help me in my teaching career. This is because now I can use different skills and strategies to explain value-added tax (VAT) to students. I have now understood the concept of value addition in the production distribution chain and its associated computations.*

Thus, the two cohorts of PSATs did not only provide quality information in their lesson plan documents but also provided good explanations of concepts in the subject matter. They reiterated that as a result of their improved content knowledge (CK), they were able to use appropriate illustrations to support the explanations of the concepts involved in the topics they taught.

Even though the study has shown a positive change in the pre-service teachers' through their developed TPACK, they encountered some challenges that have the potential to impede efficient development of teachers' TPACK. Key among the challenges was the inadequacy of ICT resources in the classrooms. It was observed during the lesson implementation in one Senior High School that classrooms did not have projectors for lesson deliver; computers available were also woefully inadequate. Similar problem was observed in the second school where the teaching try-out took place. None of the two schools had internet connectivity during the implementation of the lessons.

This posed challenges to the teachers during the implementation of the lesson indicating that lack of ICT resources (such as projectors, computers and internet connectivity) in the classrooms is likely to hinder ICT implementation in Senior

High Schools.

4. Discussions

The study focused on exploring how pre-service teachers developed their TPACK in designing and implementing audio-visual supported lessons. The pre-service teachers worked in groups of two to design audio-visual supported lessons after going through professional development training. The audio-visual lessons designed by the PSATs were implemented in both micro and peer teaching sessions as well as in the real SHS classroom context. The results obtained from the analyses of the lesson artefacts, interviews, observation and questionnaire indicated that the PSATs developed their TPACK during the PDA. Generally, there was an improvement in all the TPACK components for the PSATs (as depicted in **Table 2** and **Table 3**) as well as depicted in the interview and observation data. The survey data in particular showed improvement in all the components of TPACK, with the largest areas of change occurring in technology-related sub-scales: TPACK (gain = 1.87), TPK (gain = 1.50), TCK (gain = 2.35), and TK (gain = 1.75). This is an indication that the pre-service teachers developed their TPACK in the technology-related sub-scales much better as they might have perceived them as new knowledge as was also described in Author (2012).

What was intriguing however, was that the pre-service teachers did not only develop their TPACK as a unique body of knowledge but also sought to bring to light the simple combination of the three knowledge bases during their teaching with the audio-visual based lessons (see **Figure 3** and **Figure 5**) as was evident in their planned and implemented lessons (i.e. lesson plans, and presentation slides). This finding clearly shows that views about the nature of the TPACK model (Mishra & Koehler, 2006) are fundamental for providing the basis for understanding how teaching improved based on the pre-service teachers developed TPACK in the context of the study. This apparently led to a positive change in the prospective teachers' ways of teaching Accounting.

The evidence from the results also showed that the PSATs of the study showed weak knowledge in all TPACK components except for CK and PK before the PDA. For instance, some of the PSATs did not know how to download videos from YouTube and also hyperlink a video or a document in a PowerPoint presentation. However, due to their experiences and the nature of the training received from the teacher preparation programme, the PSATs were more knowledgeable about their content (CK) and pedagogy (PK) as compared to other components of the TPACK. This notwithstanding, the results showed that the PSAT developed their CK much further after the PDA; they gained a deeper understanding of concepts which they had not understood earlier which consequently helped them to teach the subject much better. This aligns with similar studies (Agyei, 2012) which have showed improved subject matter or content of pre-service teachers who engaged with technology to design and enact ICT-supported lessons. Agyei (2012) and Niess, Sandri and Lee (2007) reiterate

that such developed content knowledge consequently impacts teachers' presentation of certain concepts they would have found difficult to develop as was observed in this study.

One of the reasons for the developed TPACK and improved content knowledge (CK) among the pre-service teachers was the nature of the PDA which was in three (3) stages: 1) an introductory workshop for the teachers, 2) design of ICT-supported lessons by the pre-service teachers in teams, and 3) implementation of the lessons designed by the PSATs. This finding seems to align with studies that showed that teachers' professional development programmes played a significant role in the effective integration of ICT in education (Ho, Watkins, & Kelly, 2001; Hew & Brush, 2007). Kazemi and Hubbard (2008) and Opfer and Peder (2011) have emphasized the need for more complex understandings, arguing that PDA has the potential to impact many aspects of teachers' professional and personal lives, impacting on teachers' knowledge, competences, and values as was observed in this study. The PDA in this study allowed the teachers to design, implement and redesign lessons based on the feedbacks received during teaching try-outs of their designed lesson creating a platform for the teachers to interact with one another thereby sharing their professional competencies to develop ICT-solutions to authentic pedagogical problems.

Notwithstanding the positive change in the pre-service teachers developed TPACK, there were some obstacles that prevented a successful implementation of the audio-visual based lessons in SHS classrooms. These were the non-availability of projectors, inadequate computers and lack of internet connectivity. Lack of these ICT resources in SHSs will not promote and motivate teachers to use technology in teaching. Ohiwerei, Ohiole, Azih and Okoli (2013) confirmed that lack of ICT resources such as computers, no electricity in schools, no internet connectivity and obsolete computers do not promote efficient implementation of ICT in schools. It is therefore important that Parent Teachers' Association, School Management and Boards put priority on the provision of ICT facilities in Ghanaian schools (e.g. mathematics laboratories, computers and projection devices in classrooms) to facilitate and increase access of teachers; easy access to ICT resources in senior high schools will certainly promote effective integration of ICT in teaching.

Practical implications

The study brought to light the significance of using audio-visuals in teaching; but also revealed that effective use of ICT in the classroom will require the development of teachers' technology knowledge and skills. Several implications for professional development and teacher support for ICT integration can be inferred from the study. Thus, the study advocates that increasing teachers' ICT competencies should be an integrated part of the design of professional development arrangements for prospective and practicing teacher education. This suggests that teacher education institutions need to include courses on pedagogical issues related to ICT integration in their curriculum; while teacher in-service training providers make conscious efforts to provide extensive professional de-

velopment opportunities that focus on training practicing teachers to acquire skills on how to integrate ICT effectively in their instruction. This will ensure that trained teachers are competent and sufficiently prepared for new teaching methods which are flexible and involve appropriate use of technology. Again, the study has shown that efficient ICT integration requires investment in ICT infrastructure in schools. Though the government of Ghana in time past has put in place support systems in schools to facilitate access to computer, access probably continues to be an issue in secondary schools. In order to support government efforts, other stakeholders including parents, school management and boards must also put priority on the provision of ICT facilities in schools to facilitate and increase access of teachers. Easy access to ICT t will certainly contribute to teachers' use of ICT in the schools.

5. Conclusion

The study brought to light the essence of teachers' TPACK for effective integration of technology in teaching. The study supports the argument by Mishra and Koehler (2006) that TPACK is a useful analytic lens for studying teachers' integration of technology, content and pedagogy. These highlights are clear indications that the teachers' TPACK is a requirement for effective use of ICT in teaching and that in preparing teachers to teach with technology, the framework has the potential to develop teachers' experiences and the set of competencies they need to successfully integrate technology in their educational practices. Evidence from the study has also shown that fusing of ICT in teaching at the SHS level will require effective training and much time on the part of teachers to carefully plan their lessons. Thus, the study highlights the need for a more systematic effort to engage pre-service teachers in technology-rich design activities, to develop their TPACK adequately.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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