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<https://doi.org/10.1057/s41599-023-01713-y>

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Pedagogical competencies in minor subjects of Ghanaian pre-service geography teachers and their implications for teacher education

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Despite the proliferation of research on teacher education, pre-service teachers' pedagogical preparedness to teach their minor subjects has received little attention in the literature. Therefore, this study assessed Ghanaian pre-service geography teachers' pedagogical competence in their minor subjects, including political science, economics, social studies, and history. Pedagogical competence was conceptualised using three constructs adapted from the Technological Pedagogical Content Knowledge (TPACK) framework: pedagogical knowledge, pedagogical content knowledge, and technological pedagogical knowledge. Through a survey, a total of 182 pre-service geography teachers participated in the study. The empirical data obtained were analysed using descriptive statistics such as mean and standard deviation. A one-way MANOVA test was conducted to explore the differences in the pre-service teachers' pedagogical competencies based on minor subject classifications. The results showed that the pre-service geography teachers had relatively higher pedagogical knowledge in their minor subject than pedagogical content and technological pedagogical knowledge. Minor subject classifications significantly affected pedagogical knowledge, with higher scores reported among the economics minor group. The implications of the findings for teacher education curricula, in addition to the need for pre-service teachers to read pedagogy-related courses in their minor subjects, are discussed.

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Introduction

Globally, there is an increasing concern about the quality of teacher training. Issues about teacher education and professional competencies have gained attention in recent literature (Havia et al., 2022; Fogal, 2017; Urban et al., 2018; Lauermann and Johannes, 2016). As envisaged in Sustainable Development Goal 4 (Ojewunmi, United Nations, 2020), equitable quality education can be achieved when well-trained and professionally competent teachers occupy classrooms. As initially theorised by Shulman (1987) and supported later by many studies (Mensah et al., 2022; Ababio and Dumba, 2014; Mishra and Koehler, 2006; Urban et al., 2018; Schmidt et al., 2014), professionally competent teachers are expected to possess adequate pedagogical content knowledge. Although Mishra and Koehler (2006) introduce another facet of teacher competence called technological knowledge, their model recognises the value of pedagogical knowledge in teacher professionalism. In the present study, the pre-service geography teachers' pedagogical competencies in their minor subjects were measured using three constructs of teacher knowledge: pedagogical knowledge, pedagogical content knowledge, and technological pedagogical knowledge. These three constructs focus on teachers' familiarity with subject-specific instructional techniques and how these techniques could be applied for specific content delivery and technological use. They, therefore, constitute a valid measure of pedagogical competence in general.

Minor subject teaching is common to the educational landscape of Ghana. Minor subject teaching is often associated with senior high schools (as in the case of Ghana and many other West African countries) or high schools elsewhere. In general terms, minor subject teaching is prominent in secondary schools. In Australia and Slovenia (Bezjak et al., 2020), Germany (Glutsch and König, 2019; Rösel and Köhler, 2018), and Finland (Lavonen, 2007), pre-service teachers select minor subjects in addition to the main subject they are prepared to go and teach. Within the University of Education, Winneba, like many other teacher education universities in Ghana, pre-service teachers who are prepared to teach in senior high schools often select a minor subject area related to their field of study. For instance, the pre-service geography teachers who participated in the current study could select political science, social studies, history, or economics as their minor subjects upon admission. Studies examining pre-service teachers' motivating factors for choosing a particular minor subject are rare.

Notwithstanding, a narrative study conducted by Havia et al. (2022) revealed that pre-service teachers' choice of minor subjects is significantly influenced by job market demand and the connectedness of subjects. These findings suggest that there may be greater job opportunities for students with both majors and minors. Thus, student-teachers who graduate with both major and minor subjects may be employed to teach either their minor or major subjects, but not necessarily their major subjects only. Therefore, these student-teachers must be adequately prepared in both minor and major subjects before entering the classroom.

The problem is that pre-service teachers tend to give disproportionate attention to their minor subjects. They tend to focus more on their majors and neglect their minors, although they will be certified in both subjects after their training. Others tend to lose interest in their minor subjects during training (Spaeth-Hilbert and Seufert, 2013). However, pre-service teachers trained to teach at the senior high school level are often required to select minor subjects from a related field during their initial training.

Due to the nature of this training, teachers that get posted to senior high schools are sometimes assigned their minor subjects to teach. This is very common in Ghana. It is, therefore, expedient

that the curricula used by teacher education institutions be designed in a way that leads to the acquisition of adequate pedagogical competencies (Shulman, 1987; Schmidt et al., 2014; Ababio and Dumba, 2014). This will contribute to solving the problem of out-of-field teaching (Ingersoll, 2019; Kwakye Apau, 2022). Whether being trained to teach their major or minor subjects, Ghana's National Teacher Education Curriculum Framework (Ministry of Education Ghana, 2017) requires that these pre-service teachers are provided with quality training through initial and continuing teacher development.

Assessment of pre-service teachers' pedagogical competence in their minor subjects has received little attention in the literature. Studies that exist on measuring teacher competencies are skewed towards assessing in-service or pre-service teachers' technological pedagogical content knowledge (TPACK) with emphasis on their major subjects (Mensah et al., 2022; Urban et al., 2018; Santos and Castro, 2021; Schmidt et al., 2014). Again, the few studies that seem to pay attention to pre-service teachers' minor subjects (Spaeth-Hilbert and Seufert, 2013; Rösel and Köhler, 2018; Stock and Stock, 2018; Havia et al., 2022) only focus on exploring motivations and challenges associated with studying or teaching minor subjects. For instance, a study conducted by Havia et al. (2022) in Finland examined three pre-service subject teachers' lived experiences of their passion for their minor and major subjects. The study concluded that, compared to their major subjects, pre-service teachers showed less enthusiasm for their minor subjects. This situation raises the question of whether pre-service teachers develop adequate pedagogical competencies in minor subjects they will teach in the future. There is, therefore, a need to systematically assess pre-service teachers' pedagogical competencies in their minor subjects. Developing adequate pedagogical competencies in minor subjects helps tackle the widespread problem of "out-of-field" teaching, which has dire consequences on pupils' learning outcomes (see Ingersoll, 2019; Kwakye Apau, 2022). Assessing pre-service teachers' pedagogical preparedness is essential to address the challenge of poor selection of pedagogical strategies in instructional delivery in minor subjects. Knowledge of pre-service teachers' pedagogical competencies, particularly in their minor subjects, provides insights for teacher education institutions and teacher educators on curriculum design considerations that ensure holistic teacher training.

This study therefore sought to answer the following research questions: What is pre-service geography teachers' pedagogical competence preparedness to teach their minor subjects? How does the pre-service geography teachers' pedagogical competence level differ in their minor subject groupings? The answers to these questions were used to analyse the implications for teacher education curriculum frameworks. The pre-service teachers involved in this study were students whose major subject was geography but who studied minor courses in political science, social studies, history, or economics at the University of Education, Winneba, in Ghana. The study adopted a cross-sectional survey design with a quantitative data processing and analysis approach. A one-way MANOVA test was conducted to explore the difference in the pre-service geography teachers' pedagogical competence in terms of the different minor subjects.

Minor subject teaching

In teacher training, "minor subject" refers to any subject a pre-service teacher reads in addition to their main area of specialisation during the initial training period. For example, the pre-service teachers involved in this study studied geography as their main subject while studying political science, history, economics, and social studies as minor subjects (thus, a combination of

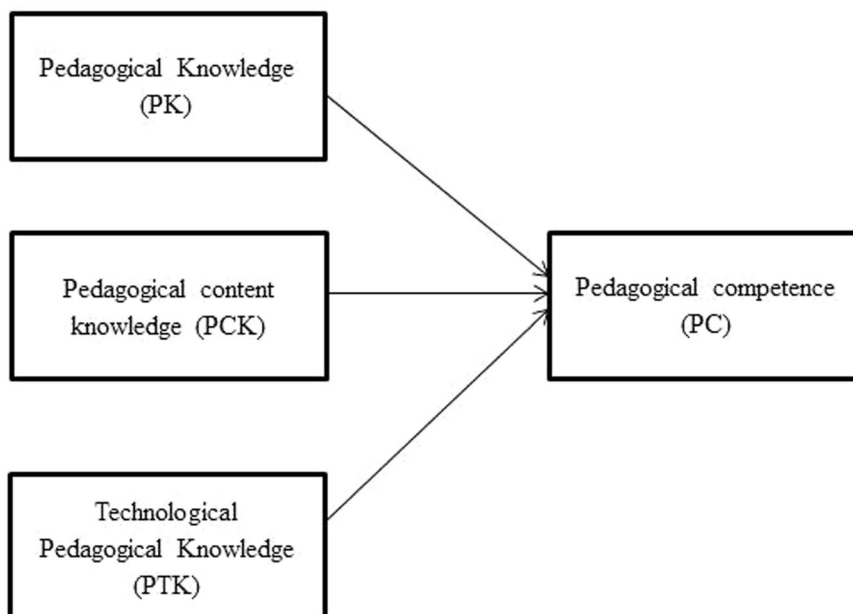


Fig. 1 Pedagogical competencies (PC) model. The PC model was adapted from Koehler and Mishra's (2006). TPACK framework to explain three sets of constructs of teacher knowledge (pedagogical knowledge, pedagogical content knowledge, and technological pedagogical knowledge) used in the context of the current study to measure pre-service teachers' pedagogical competencies in their minor subjects.

geography and any one of these subjects). Several factors motivate students to select their minor subjects. These reasons include developing subject-specific identities (Lutovac and Kaasila, 2018; Salonen and Havu-Nuutinen, 2022), the belief that studying minor subjects offers an advantage in terms of job search, and increased chances of getting scholarships for higher education (Dissanayake, 2017). However, studies have shown that students' interest in minor subjects is often limited as they focus on the main subject of their studies. Also, they invest little time to compensate for missing previous knowledge. While this is regrettable from the instructors' viewpoint, it is a coherent approach from the students' side (Havia et al., 2022; Winzker, 2010). The idea of minor subject training is to widen pre-service teachers' job prospects (Saukkonen et al., 2013) and expose students to multidisciplinary knowledge (Havia et al., 2022). Therefore, it is problematic if pre-service teachers are not interested in their minor subjects. This implies that when employed, these teachers may be unable to deliver lessons effectively in their minor subjects. In light of this, this study attempts to establish the level of pre-service geography teachers' pedagogical preparedness prior to receiving postings to the classroom.

Measuring pedagogical competence

Pedagogy is an indispensable aspect of teacher knowledge (Shulman, 1987; Ababio and Dumba, 2014; Mullock, 2006) required for effective classroom teaching and learning. "Pedagogical competence" has not been clearly conceptualised in the literature. However, its contributing variables or constructs have been adequately measured either in isolation (Mullock, 2006) or jointly with other variables, particularly in most TPACK studies (Schmidt et al., 2014; Santos and Castro, 2021; Schmid et al., 2021; Mensah et al., 2022). There is enough evidence to suggest that teachers' effectiveness in the classroom goes beyond the possession of adequate knowledge of the subject matter (Schmidt et al., 2014). Extending the work of Shulman (1987), Mishra and Koehler (2006) examined the relationship that exists between content, pedagogy, and technology and consequently proposed seven facets of teacher knowledge: content knowledge (CK),

pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPCK). Three of these seven constructs could be merged to define the general pedagogical competence of teachers: PK, PCK, and TPK (see Fig. 1). Thus, the current study adapts the TPACK model to measure pedagogical competence by using three out of the seven constructs that relate to pedagogy.

Pedagogical knowledge focuses on teachers' capacity to choose instructional strategies and processes, including their familiarity with lesson planning, assessment, classroom management, and student learning in their minor subjects (Shulman, 1987; Mishra and Koehler, 2006). Pedagogical Content Knowledge deals with the pre-service teachers' "understanding of how particular topics, problems, or issues are organised, represented, and adapted to the diverse interests and abilities of learners" and presented for instruction (Shulman, 1987, p. 8). On the other hand, technological pedagogical knowledge looks at their ability to select the most appropriate technology based on its suitability for specific instructional techniques or strategies (Schmidt et al., 2014). In view of this, pedagogical competence (the totality or sum of PK, PCK, and TPK) could be explained as teachers' knowledge of appropriate instructional methods and techniques derived from general educational aims and consistent with learner characteristics, with these strategies or methods tailored to specific subject matter content and recognising the role of technology in implementing such instructional strategies in the classroom. Thus, in measuring the pre-service geography teachers' pedagogical competence in their minor subjects, they were made to self-report their knowledge or understanding of the PK, PCK, and PTK constructs.

Methodology

All the pre-service teachers who participated in this study were final-year (Level 400) students majoring in geography. As part of their training, the university requires that they select a minor subject from which individual semester-by-semester courses are selected in addition to those assigned to them in their major.

Thus, the pre-service geography teachers take minors in four subjects: political science, social studies, history, and economics, all of which belong to the Faculty of Social Sciences Education. As Havia et al. (2022) noted, selecting all of your courses from the same subject group may have some benefits. In addition, the pre-service teachers take general university and educational courses meant to expose students to fundamental concepts in teaching and learning and academic writing. There are subject-specific methodology or didactics courses that are often taken by only major students. Thus, for example, pre-service geography teachers minoring in economics may not read a course in economics didactics. It is assumed that the general education courses read by all students would equip them with fundamental teaching principles. Nevertheless, whether these pre-service geography teachers will indeed become pedagogically competent in their minor subjects still needs to be answered.

There were 369 final-year pre-service geography teachers studying with the Department of Geography Education. Using a cross-sectional survey design (see Kesmodel, 2018; Zangirolami-Raimundo et al., 2018), a total of 182 final-year pre-service geography teachers, representing 49.32%, participated in an online survey. The study used a survey because it makes it possible to gather a large sample size for a study, providing a basis for accurate generalisations (Gray, 2004). It, therefore, aids in (1) describing the nature of an existing phenomenon (Cohen et al., 2007), (2) gathering information about attitudes that are challenging to measure using observation (McIntyre, 1999) and (3) having the power to give all respondents a standard stimulus and reduce researcher biases (Sarantakos, 2013). The data was collected when the pre-service geography teachers were undertaking their internship programme (off-campus teaching practice) at various senior high schools in Ghana. The online survey questionnaire was sent to the pre-service geography teachers via a typical social media platform used by them, with constant reminders to respond. After 3 months, 182 people responded to the survey questionnaire. The respondents were predominantly male (77%). This is partly explained by the seeming male dominance in the study of geography in higher education (see Opuku, 2019; Obadaki and Omowumi, 2013) and is mainly attributable to the male-dominated nature of the geography department where the study took place. Respondents' willingness to participate in the online survey may also have contributed to increasing the gender disparity. Willingness to participate in the survey could be a function of convenience and ease of use of digital technology (see Goswami and Dutta, 2016). Table 1 summarises the demographic details of the respondents.

Following the introduction of the TPACK model by Mishra and Koehler (2006), several researchers have developed questionnaire scales to measure the different areas of teacher

knowledge (Schmidt et al., 2009; Kabakci Yurdakul et al., 2012; Valtonen et al., 2017). These scales take a generalistic approach to measuring teacher competence without considering subject-specific complexities. Given this, the online questionnaire used for this study was adapted from a survey questionnaire developed by Su et al. (2017) to precisely measure pre-service geography teachers' TPACK. For this study, three out of the seven constructs: pedagogical knowledge (PK), pedagogical content knowledge (PKC), and technological pedagogical knowledge (TPK), were adapted. These three constructs constitute teachers' pedagogical competence. Each construct had a list of five-point interval Likert scale items ranging from "strongly disagree" to "strongly agree." The constructs' reliability and the items' internal consistency were ascertained using Cronbach's alpha and were found to range from 0.75 to 0.91. According to Bolarinwa (2015), satisfactory reliability in SPSS is defined as an alpha reliability coefficient of 0.70 or higher. The items were therefore deemed reliable. The data were interpreted using descriptive statistics such as weighted means and standard deviations. Similar to a Likert scale score of 4.1–5.0, this score "strongly agrees" demonstrates adequate knowledge; a mean score of 3.1–4.0 representing "agree" demonstrates fair knowledge; a mean score of 2.1–3.0 representing neither agree nor disagree demonstrates low knowledge; and a mean score of 1.1–2.1 representing "strongly disagree" demonstrates extremely low knowledge. A mean score of 1.0 and 5.0 represent the lowest and highest average scores, respectively. A one-way MANOVA test was conducted to compare the pedagogical competencies of the pre-service geography teachers based on their minor subject groupings. Preliminary assessments of normality, outliers, linearity, homogeneity of variance-covariance matrices, and multicollinearity were conducted to ensure that the data was fit for the analysis.

Results

Pre-service geography teachers' pedagogical knowledge in minor subjects. This construct assessed pre-service geography teachers' pedagogical knowledge in their minor subjects. Pre-service geography teachers were explicitly asked to rate themselves on a number of statements related to their capacity to choose instructional strategies and processes, including their familiarity with lesson planning, assessment, classroom management, and student learning in their minor subjects (Shulman, 1987; Mishra and Koehler, 2006). Table 2 shows the outcome of pre-service teachers' scores on PK.

The results in Table 2 demonstrate that the majority of the pre-service geography teachers generally possessed adequate knowledge of pedagogy in their minor subjects, with an average mean score of 4.29. This was an indication that the pre-service teachers possessed adequate knowledge of using different pedagogical methods to teach their minor subjects for specific situations (such as teaching content, student level, etc.), guiding students to adopt appropriate learning strategies, guiding students to discuss subject topics effectively in group activities and knowledge of techniques for evaluating students' performance. Teachers' rating was highest ($M = 4.47$, $SD = 0.89$) on this item: "I can guide students to discuss subject topics effectively in group activities in my minor subject." This implies that pre-service teachers can contribute significantly to promoting learner-centred learning approaches in the classroom for optimum student learning. However, the lowest mean score was recorded: "I can design challenging tasks to facilitate students' thinking in my minor subject." This is potentially disturbing if teachers do little to assist students with challenging tasks that help develop critical thinking skills.

Table 1 Summary of respondents' demographic characteristics.

Variable	Categories	Frequency (%)
Sex	Male	140(77%)
	Female	42(23%)
Age	20-29	162(89%)
	30-39	20(11%)
	Minor subject	
	Social studies	60(33%)
	History	16(9%)
	Economics	24(14%)
	Political science	82(45%)
		$N = 182$

Table 2 Pedagogical knowledge.

Pedagogical knowledge	Mean	SD	Descriptor
I can use different pedagogical methods to teach my minor subject for specific situations (such as teaching content, student level, etc.).	4.29	0.845	Adequate knowledge
I can apply different pedagogical techniques (brainstorming, experimental demonstration, etc.) in teaching my minor subject according to specific situations (such as teaching content, student level, etc.).	4.29	0.804	Adequate knowledge
I can guide students to adopt appropriate learning strategies when teaching my minor subject.	4.27	0.941	Adequate knowledge
I can guide students to discuss subject topics effectively in group activities in my minor subject.	4.37	0.888	Adequate knowledge
I know how to evaluate students' performance/assessment in my minor subject.	4.29	0.895	Adequate knowledge
I can design challenging tasks to facilitate students thinking in my minor subject.	4.08	0.907	Adequate knowledge
I can develop routine assessment tools for teaching my minor subject (such as multiple-choice questions, short answer questions, evaluation rubrics for student works, etc.)	4.32	0.852	Adequate knowledge
I can prepare lesson plans for the various topics in my minor subject.	4.44	0.869	Adequate knowledge

M mean, *SD* standard deviation.

Table 3 Pedagogical content knowledge.

Pedagogical content knowledge	Mean	SD	Descriptor
Even without the use of information technologies, I can help students solve real-world problems related to my minor subject.	4.00	0.928	Adequate knowledge
Even without the use of information technologies, I can break down the teaching objectives of each content area in my minor subject area curriculum.	3.98	0.975	Fair knowledge
Even without the use of information technologies, I can guide students to carry out theme-based enquiry activities in my minor subject.	3.93	0.950	Fair knowledge
Even without the use of information technologies, I can select appropriate evaluation tools to assess student performance in my minor subject.	4.02	0.916	Adequate knowledge
Even without the use of information technologies, I can determine what concepts need to be evaluated in the study of my minor subject.	4.09	0.936	Adequate knowledge
I can produce lesson plans with a good understanding of the topic in my minor subject matter.	4.42	0.842	Adequate knowledge

M mean, *SD* standard deviation.

Pre-service geography teachers' pedagogical content knowledge in minor subjects. This construct aimed to assess pre-service geography teachers' pedagogical content knowledge in their minor subjects. Pre-service geography teachers were specifically asked to rate themselves on a number of statements related to their "understanding of how particular topics, problems, or issues are organised, represented, adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987, p. 8). The results showed that the pre-service teachers' self-reported competence declined when it came to pedagogical content knowledge. Table 3 shows the outcome of this construct.

It can be observed from the results in Table 3 that, compared to PK, the pre-service teachers' level of confidence in PCK declined to an average mean score of 4.07. The highest mean score under the PCK construct was recorded for the statement, "I can produce lesson plans with a good understanding of the topic in my minor subject matter." This is, however, important since lesson planning is an essential aspect of teacher preparation. Beyond this, the majority of the pre-service teachers had adequate knowledge of selecting appropriate evaluation tools for assessing student performance in their minor subjects. In sharp contrast, the lowest mean scores ($M = 3.93$, $SD = 0.95$, and $M = 3.98$, $SD = 0.98$) were recorded when it came to their ability to break down the teaching objectives of each content area and guide students to carry out theme-based enquiry activities in their minor subjects. These should be a great concern for teacher education institutions.

Pre-Service geography teachers' technological pedagogical knowledge in minor subjects. This construct assessed pre-service geography teachers' technological pedagogical knowledge in their

minor subjects. Pre-service geography teachers were asked to rate themselves on a number of statements related to their ability to select the most appropriate technology on the basis of its suitability for specific instructional techniques or strategies (Schmidt et al., 2014) in their minor subjects. This domain further assesses an understanding of how technology can present both constraints and affordances to specific pedagogical practices used in teaching their minor subjects. Like PCK, the pre-service teachers' confidence dropped appreciably compared to their PK, recording an average mean of 4.07. Table 4 shows the outcome of this construct.

Knowing and understanding the pedagogical use of technology in the classroom is important in the 21st century. The results showed that the majority of the pre-service teachers had adequate knowledge of using information technologies to enhance students' enthusiasm for learning in their minor subjects. This item recorded the highest mean score ($M = 4.25$, $SD = 0.86$). Again, a significant proportion of pre-service teachers ($M = 4.20$, $SD = 0.92$) had sufficient knowledge of using information technologies to engage students in active participation in classroom activities in their minor subjects. Once they are able to arouse students' enthusiasm by selecting the appropriate information technologies, it is obvious that their participation will be high. In contrast, the lowest mean scores under PTK were recorded for the items "I see the use of information technologies in my minor subject area classroom from a critical perspective" ($M = 3.95$, $SD = 0.96$) and "I can adaptively use information technologies in various teaching activities in my minor subject area" ($M = 3.90$, $SD = 0.98$). The ability to adapt information technologies in different classroom contexts is a skill that pre-service teachers need to improve upon.

Table 4 Technological pedagogical knowledge.

Technological pedagogical knowledge	Mean	SD	Descriptor
I can choose appropriate information technologies to optimise teaching of my minor subject area.	4.02	0.986	Adequate knowledge
I can utilise information technologies to improve classroom interaction when I am to teach my minor subject area.	4.12	0.938	Adequate knowledge
I can use information technologies to enhance students' enthusiasm for learning my minor subject area.	4.25	0.862	Adequate knowledge
I can use information technologies to engage students to actively participate in classroom activities in my minor subject area.	4.20	0.919	Adequate knowledge
I see the use of information technologies in my minor subject area classroom from a critical perspective.	3.95	0.956	Fair knowledge
I can adaptively use information technologies in various teaching activities in my minor subject area.	3.90	0.975	Fair knowledge
I can select appropriate information technologies to optimise teaching of my minor subject area.	4.08	0.919	Adequate knowledge

M mean, *SD* standard deviation.

Table 5 Multivariate tests.

Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta squared	
Minor subject	Pillai's trace	0.144	2.996	9.000	534.000	0.002	0.048
	Wilks' lambda	0.861	3.022	9.000	428.488	0.002	0.049
	Hotelling's trace	0.156	3.021	9.000	524.000	0.002	0.049
	Roy's largest root	0.105	6.246	3.000	178.000	0.000	0.095

Table 6 Tests of between-subjects effects.

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared	
Minor subject	Pedagogical knowledge	306.562	3	102.187	3.719	0.013	0.059
	Pedagogical content knowledge	52.514	3	17.505	1.017	0.387	0.017
	Technological pedagogical knowledge	145.145	3	48.382	1.811	0.147	0.030
Error	Pedagogical knowledge	4890.317	178	27.474			
	Pedagogical content knowledge	3064.322	178	17.215			
	Technological pedagogical knowledge	4756.305	178	26.721			
Total	Pedagogical knowledge	219826.000	182				
	Pedagogical content knowledge	111824.000	182				
	Technological Pedagogical knowledge	152902.000	182				

^aR Squared = 0.059 (Adjusted R Squared = 0.043).

^bR Squared = 0.017 (Adjusted R Squared = 0.000).

^cR Squared = 0.030 (Adjusted R Squared = 0.013).

^dComputed using alpha = 0.05.

Differences in pedagogical competencies among minor subject groupings. A one-way MANOVA test was conducted to establish whether the pre-service geography teachers' pedagogical competencies differed in terms of their minor subject groupings (social studies, political science, history, and economics). There were three dependent variables: PK, PCK, and PTK. Initial checks were carried out to assess normality, outliers, linearity, homogeneity of variance-covariance matrices, and multicollinearity. The results of Shapiro-Wilk's tests supported the assumption of univariate normality by showing that all three dependent variables were normally distributed in the four minor subject groupings ($p > 0.05$). The assumption of multivariate normality was supported by all Mahalanobis distance values falling below 16.27, indicating the absence of any multivariate outliers. Box plots showed that there were no univariate outliers. Scatterplots indicated that the dependent variables were linearly related in all subject groupings. Box's *M* test indicated that the assumption of homogeneity of variance-covariance matrices was met, $p = 0.912$. A Pearson's correlation analysis revealed that the multicollinearity assumption was met ($r = 0.73$, $n = 182$, $p < 0.001$).

Multivariate test statistics for the group variable and partial eta squared representing effect size are shown in Table 5. The test

result shows that there was a significant effect of minor subject groupings on pedagogical competence: $F(9, 428) = 3.02$, $p = 0.002$, Wilk's $\lambda = 0.86$, and $\eta_p^2 = 0.05$. In addition to Wilks' lambda, all other multivariate statistics were significant ($p < 0.001$). These included Pillai's trace, Hotelling's trace, and Roy's largest root.

Table 6 shows the result of the test of between-subjects effects. Using a Bonferroni-adjusted alpha of 0.02, there was a significant effect of minor subject groupings on pedagogical knowledge, $F(3, 178) = 3.72$, $p = 0.013$, $\eta_p^2 = 0.06$, with scores higher in the economics minor group ($M = 36.58$, $SD = 5.38$) compared to history ($M = 31.13$, $SD = 6.08$), political science ($M = 34.00$, $SD = 5.43$), and social studies ($M = 34.34$, $SD = 4.66$). There was, however, no significant effect of minor subject groupings on pedagogical content knowledge ($F(3, 178) = 1.02$, $p = 0.387$, $p^2 = 0.02$) and technological pedagogical knowledge ($F(3, 178) = 1.81$, $p = 0.147$, $p^2 = 0.03$).

Discussion

Several studies have provided useful insights into the different facets of teacher competencies required for effective classroom instruction (Rafiq and Yunus, 2022; Schmid et al., 2021; Mensah

et al., 2022), especially with regard to competencies that are relevant in the 21st century. However, most of these studies have been devoted to assessing in-service and pre-service teachers' general competence in their major subject areas. Such studies are usually situated within the TPACK framework proposed by Mishra and Koehler (2006). The present study extends the conversation by examining pre-service geography teachers' pedagogical competence and preparedness to teach their minor subjects, including political science, economics, history, and social studies.

Regarding the level of pre-service geography teachers' pedagogical competency and preparedness to teach their minor subjects, analysis of the empirical data showed results similar to previous studies (Owusu, 2014; Santos and Castro, 2021). Specifically, the pre-service geography teachers demonstrated mastery of pedagogical knowledge in their minor subject areas. This means that the pre-service geography teachers generally had adequate expertise in choosing instructional techniques and approaches suitable for lessons in their minor subjects and were familiar with lesson planning, classroom management, and assessment of student learning (Shulman, 1987; Mullock, 2006). Though this study takes a divergent focus from most previous studies by looking at self-reported competencies in pre-service teachers' minor subjects, this finding is similar to the evidence of studies by Urban et al. (2018), Schmid et al. (2021), and Apau (2017), where pre-service teachers showcased adequate knowledge of pedagogy. However, what makes this finding unique is that although it is perceived that student-teachers tend to pay little attention to and have low interest in their minor subjects (Havia et al., 2022), the present study challenges such an assertion. The results further showed that, contrary to their high confidence level in pedagogical knowledge, the pre-service geography teachers' pedagogical content knowledge and technological pedagogical knowledge were relatively lower. While the relatively low pedagogical content knowledge reported by pre-service geography teachers was surprising in comparison to most studies (Nyamekye et al., 2022; Mensah et al., 2022), the relatively high technological pedagogical knowledge was consistent with the findings of Nyamekye et al. (2022), Mensah et al. (2022), and Apau (2017). For instance, in Apau's (2017) study conducted in one of Ghana's teacher education universities, it was found that pre-service teachers needed to be more sure of their ability to use technology to improve their teaching methods. This finding suggests that despite the increased investment in information and communication technology resources for educational institutions in Ghana, the gains in pedagogic use of technology are yet to be fully realised. Consequently, it is common to assume that these pre-service teachers are likely to face some difficulties should they be posted to teach their minor subjects.

The study explored the differences in the level of pedagogical competence among pre-service geography teachers based on minor subject classifications. The study found a significant effect of minor subjects on the level of pedagogical knowledge, with higher scores reported among the economics minor group. This finding supports Havia et al.'s (2022) observation that choosing subjects from the same field or subject group presents some advantages. Thus, the current finding expands our understanding of how subject matter and general instructional strategies and approaches relate across different fields by demonstrating that the kind of minor subject pre-service teachers selects is a predictor of their level of pedagogical knowledge. This result is important as it provides teacher education institutions with some basis to guide student-teacher decisions regarding the choice of a minor subject. However, it was found that the types of minor subjects pre-service geography teachers selected had little effect on their pedagogical content knowledge and technological pedagogical knowledge. This could be explained by the complexity of these two

knowledge constructs as compared to pedagogical knowledge. These opposing associations imply that although teachers' understanding of a variety of teaching practices, strategies, and methods used to improve students' learning, assessment, and classroom management (pedagogical knowledge; Schulman, 1987) in one subject could be transferred and used in another subject that is closely related, there are limitations to applying one's understanding of how particular topics, problems, or issues are organised, represented, and tailored to the varied interests and learning styles of students in one subject to even a closely related subject.

In most teacher education universities in Ghana, the number of courses that pre-service teachers are required to select from their minor subjects is mostly limited. For example, the pre-service teachers involved in this study had political science, history, economics, and social studies as their minors. They, therefore, did not read all the courses in their minor fields; only those reading these minor subjects as their majors were entitled to all the courses. In view of this, what may have accounted for the lower pedagogical content knowledge and technological pedagogical knowledge in minor subjects reported by these future teachers is that, usually, they are not required to read didactic courses in their respective minor subjects. This study, therefore, recommends that the reading of didactic courses (such as Instructional methods in economics, Methods of teaching social studies, Instructional methodology in geography, etc.) be made a requirement for pre-service teachers, irrespective of whether the subject is their major or minor, since these courses are often designed to expose pre-service teachers to specific instructional strategies and processes, including lesson planning and classroom management approaches, and digital technologies relevant for teaching the content of a particular subject. Because as observed by Havia et al. (2022, p. 14), "just because some subjects are conceived of as a "package" and should be studied together does not necessarily mean that the students will display the same interest in them." The study further recommends that, just as geography major students are observed and assessed in a pre-service teaching practice, they should also be observed and assessed in a pre-service teaching practice in their minor subjects.

The major limitations to the extent of the generalisation of the findings of this study manifest in two forms: the inherent weaknesses of self-reported approaches and different educational contexts. Although self-reported approaches are widely adopted in most studies examining teachers' professional competencies (Rafiq and Yunus, 2022; Nyamekye et al., 2022; Santos and Castro, 2021), their inherent weaknesses are that there may be subjective interpretation or misinterpretation of items (Demetriou et al., 2015), while low-skilled respondents are likely to overestimate their competencies (Dunning, 2011). To expand and make the present study's findings more generalisable, future research should adopt observational approaches to assess pre-service teachers' minor subject competencies in real teaching contexts. Nonetheless, the present study has significantly contributed to our understanding of teacher competence in second subject areas. On the other hand, the educational policies regarding the curriculum frameworks that pre-service subject teachers are trained with vary depending on the educational context. Hence, this study's outcome would be useful to teacher educators within contexts similar to the Ghanaian one.

Conclusion

The main purpose of this study was to assess the level of pre-service geography teachers' pedagogical competence in their minor subjects, which included political science, history,

economics, and social studies, and how their pedagogical competence differed in terms of minor subject classifications. Pedagogical competence was conceptualised using three constructs adapted from the TPACK framework: pedagogical knowledge, pedagogical content knowledge, and technological pedagogical knowledge. The study concludes that the pre-service geography teachers will be able to apply the appropriate instructional strategies and processes without difficulties when posted to teach their minor subject. However, the same cannot be said in terms of their ability to apply content-specific instructional strategies and approaches with the selection of appropriate technologies that aid teaching in their minor subjects. The study finally concludes that the kind of minor subject pre-service teachers read is not a predictor of their level of pedagogical content knowledge and technological pedagogical knowledge.

Data availability

The data that underpinned this study is available upon reasonable request from the author.

Received: 2 September 2022; Accepted: 20 April 2023;

Published online: 04 May 2023

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Competing interests

The author declares no competing interests.

Ethical approval

Approval was obtained from the author's institutional Ethical Review Board (ERB). The procedures used in the study are consistent with the guidelines outlined in the Declaration of Helsinki.

Informed consent

All the respondents of this study provided a written informed consent prior to data collection. Participation was voluntary.

Additional information

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