Original Research Article

Contemporary Preservice Mathematics Teachers' Technological Pedagogical Content Knowledge Levels in Perspective: Self-reported Survey

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ABSTRACT

This study which is part of project examined the perception of preservice mathematics teachers on Technological Pedagogical Content Knowledge (TPACK) levels and the relationship among the TPACK components. The research design employed was descriptive interspersed with correlational design. The population for this study was preservice mathematics teachers at the University of Education, Winneba of Ghana. The study employed the purposive sampling technique specifically homogeneous sampling technique to select level 300 mathematics teachers from the department of mathematics education of the University of Education, Winneba. In all, the level 300 students were 183. Sample size software tool was used to determine a sample size of 125 for the study. After the determination of the sample size, simple random sampling technique was used in selecting the respondents for the study. Questionnaire was used as instrument to collect data. Data collected were analysed quantitatively. Results showed that: (i) the perceived knowledge level of the preservice mathematics teachers on TPACK and its components were moderate and high; (iii) there were positive relationships among the components of TPACK, and all of the relationships were statistically significant. Recommendations were thereof made accordingly.

Keywords: Contemporary, TPACK levels, Preservice Mathematics Teachers, ICT Integration, ICT training

1. INTRODUCTION

The availability and application of technology continue to have a significant impact on the world. As technological knowledge develops quickly, preservice mathematics teachers will have a lot of obligations and chances to use technology in the classroom once they graduate. Senior High School (SHS) students would like to use additional technology to support learning in schools, including mobile devices, smartphones, Web 2.0 applications, and social networking sites [48]; and how prepared are Ghanaian preservice mathematics teachers to guide students to use such devices?

In training preservice mathematics teachers, three developments may emerge. The first is the emphasis given to preservice mathematics teachers' acquisition of pedagogical knowledge, second is acquisition of content knowledge and the third is acquisition of technological knowledge [41]. Preservice mathematics teachers' acquisition of pedagogical knowledge, content knowledge and technological knowledge is very paramount during their training. A subject that has received a lot of attention is the expertise required for preservice mathematics teachers to use technology in mathematics instruction strategically [40; 52]. TPACK described by [40], "represents a thoughtful interweaving of all three key sources of knowledge – technology, pedagogy, and content" (p. 14). However, previous studies have not adequately taken into account preservice mathematics teachers who have taken courses in the three main domains (Content, Pedagogy and Technology) of TPACK and have been trained in how to incorporate technologies into the teaching and learning of mathematics. Besides, a review of 74 journal articles on TPACK by [13] revealed that studies in higher education setting should be carried out and more investigations into specific content areas such as mathematics are needed. Similarly, according to [42, p. 109], "… there is still much to be done — particularly in the area of measuring how TPACK works in different disciplinary contexts" such as mathematics. With the review by [13], the TPACK studies were conducted in North America, Europe, Mediterranean and Asia Pacific with no mention of any country from the Africa continent. It does not mean that studies on TPACK are not been undertaken in Africa. It may be due to the slow pace TPACK studies are undertaken in Africa and for that matter Ghana. Most TPACK studies (e.g., [3]; [11]; [12]; [51]) were one-shot trial of a technology interspersed with a pedagogic approach to measure preservice mathematics teachers' perceived levels on TPACK and its components.

The mathematics education department of the University of Education, Winneba (UEW) undergraduate programme train preservice mathematics teachers of which majority find themselves at the SHSs in Ghana. The department since 2003 has restructured her courses for the undergraduate programme of which how to use ICTs interspersed with pedagogies in the teaching of mathematics have been added. As of now, by level 300 before the preservice mathematics teachers leave for their internship programme, they would have taken 17 content courses, 6 pedagogy courses and 6 ICT courses from the mathematics education department albeit they would have taken other courses from the psychology education department, special education department, African studies department, etc.

Table 1 shows how preservice mathematics teachers of UEW are trained to integrate ICTs into the teaching and learning processes in an ICT course. As mentioned earlier, the training was done through 6 ICT courses (with different technologies) interspersed with eclectic of approaches.

Table 1. How preservice mathematics teachers were trained to integrate ICTs in teaching via ICT courses

Course	Some activities
Computer Applications for Teaching and Learning Mathematics	Student teachers through independent learning use Microsoft Mathematics Add-in to: (i) compute standard mathematical functions, such as roots and logarithms (ii) compute trigonometric functions, such as sine and cosine (iii) find derivatives and integrals, limits, and sums and products of series (iv) perform matrix operations, such as inverses, addition, and multiplication (v) perform operations on complex numbers (vi) plot 2D graphs in Cartesian and polar coordinates, and 3D graphs in Cartesian, cylindrical, and spherical coordinates (vii) solve equations and inequalities (viii) calculate statistical functions, such as mode and variance, on lists of numbers (ix) factor polynomials or integers (x) simplify or expand algebraic expressions. Students also were taught how used other mathematical software interspersed with teaching approaches in teaching mathematics concepts.

From Table 1, it is imperative to measure the preservice mathematics teachers of the Department of Mathematics Education of the University of Education, Winneba perceived knowledge levels on TPACK and its components and compare them with other works that were on a technology interspersed with a teaching approach. Therefore, this study answered the research questions: (i) what are the levels of preservice mathematics teachers' perceptions on their TPACK in the field of mathematics? (ii) what are the relationships among perceptions of preservice mathematics teachers' TK, PK, CK, PCK, TCK, TPK and TPACK?

2. THEORETICAL FRAMEWORK

To be able to examine preservice mathematics teachers' perceived knowledge levels on TPACK and its components, the theoretical framework that underpinned this study was the TPACK framework. The TPACK framework was seen as appropriate for this study because "…even as a relatively new framework, the TPACK framework has significantly influenced theory, research, and practice in teacher education and teacher professional development" ([42], p.101) such as the training of preservice mathematics teachers. Furthermore, the TPACK framework has been widely used in teacher education researches regarding technology/ICT issues (e.g.; [51]; [55]; [58]; [74]; [65]). Additionally, the TPACK framework was employed to undergird this study because of its dynamic characteristic and how researchers try different methods to measuring preservice mathematics teachers perceived knowledge levels on TPACK and its components [39]. [42] are of the opinion that, out of all the frameworks, the TPACK framework has attracted the most attention in terms of research and professional development strategies, as shown by more than 600 journal publications concerning TPACK.

TPACK is a development of Shulman's ([66]; [67]) pedagogical content knowledge framework where preservice mathematics teachers must combine different knowledge dimensions with teaching effectively using technologies. TPACK is made up of three primary parts, namely pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK). Additionally, there are three first-level hybrid components: pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), and technological content knowledge (TCK). A second level is created by combining the first-level hybrid components, TPACK, the most complex type of knowledge. Current progresses have shown a variety of techniques for measuring TPACK: hands-on assessments (performance, standardized tests, lesson plans, learning observations), interviews, open-ended questionnaires, and self-report rating scales ([1]; [76]). The self-report approach is presently one of the most normally used because it is the most efficient and inexpensive way to obtain extensive quantitative data. The seven components of TPACK have been measured using a variety of questionnaire scales by previous researchers in the form of a survey ([4]; [8]; [37]; [62]; [63]; [75]; [79]). The questionnaire scales have demonstrated the expected factor structure of TPACK and its components, which can be distinguished ([7]; [61]).

3. METHODOLOGY

This study employed descriptive design interspersed with correlational design. The population for this study was preservice mathematics teachers at the UEW of Ghana. All the preservice mathematics teachers of UEW on the four-year programme constituted the targeted population for the study. The four-year programme is a teacher training programme that allows preservice mathematics teachers to teach mainly at SHS when they graduate. In all, there are four different year groups which are level 100 students, level 200 students, level 300 students and level 400 students. The preservice mathematics teachers formed the targeted population because from level 100 to 300, they are trained in how to integrate technologies with eclectic teaching approaches in teaching concepts unlike the other preservice mathematics teachers in other higher institutions in Ghana. For instance, in a study by [2, p. 7], they stated that the preservice mathematics teachers of the University of Cape Coast in Ghana "… are novices regarding the use of technology to teach or learn mathematics" and preservice mathematics teachers of UEW are not in that regard.

The researcher employed the purposive sampling technique specifically homogeneous sampling technique ([5]; [50]; [56]) to select level 300 mathematics teachers from the department of mathematics education of the UEW. [19] intimated that purposeful sampling is when a researcher "intentionally selects participants who have experience with the central phenomenon or the key concept being explored" (p. 112). With this particular study the central theme bothers on perceived TPACK levels of preservice mathematics teachers. Also, by 300, the preservice mathematics teachers would have gone through 17 mathematics content courses, 6 mathematics pedagogy courses and 6 ICT courses and are ready to go for internship programme and they were suitable for the study. In all, there were 183 level 300 students.

Tools like the sample size software (e.g., sample size calculator) allow you to work out the sample size you need from your desired confidence level, confidence interval and size of your target population [9]. Sample size software tool was used to determine a sample size of 125 for the study with 5% margin of error, 95% confidence level and 50% response distribution (Raosoft, 2004 cited in [6]). After the determination of the sample size, simple random sampling technique was used in selecting the respondents for the study. Simple random sampling was employed because all the respondents in the population have equal chance of been selected ([21]; [49]). Also, a simple random sample gives an accurate representation of the larger population [21]. The remaining 58 students who were not in the sample took part in the think aloud process and pretesting.

Out of the 125 respondents who indicated their gender, 118(94.4%) were males and 7(5.6%) were females. The age of the respondents ranged from 18 to 34 and above. The frequency and percentage distribution in each age band was: 18-22(12, 9.6%), 23-27(94, 75.2%), 28-33(18, 14.4%), and 34 and above (1, .8%).

With the lens of TPACK framework, the research literature, and expert judgment, questionnaire was chosen to gather data for this study. With granted permissions, survey instruments by [62] and [45] were adapted. [28] stated that researchers have adapted the TPACK items because most studies show reliable outcomes when the TPACK items were used. Similarly, [78] (p. 364) claimed that "in TPACK-related literature, it is generally seen that various studies on the development of surveys and scales were conducted with preservice teachers" and in this study, preservice mathematics teachers were respondents.

The questionnaire consisted of close ended-ended items which demanded respondents to tick responses that best apply to them. It was anticipated that the calibre of respondents supplied true, genuine and reliable responses devoid of extraneous influence. The close-ended items were also aimed at ensuring uniformity in the responses and therebypreventing subjectivity of any kind. The questionnaire items were in the Likert-type scale. The questionnaire was with five response choices, "1 = poor", "2 = fair", "3 = good", "4 = very good" and "5 = excellent". That is each item response is scored with a value of 1 all the way to a value of 5. For the constructs, the respondent's responses were [63]. For example, the 7 questions/items under PK were averaged to produce one PK Score. According to [10], the Likert scale (e.g., poor to excellent) illustrates a scale with theoretically equal intervals among responses. However, [19] is of the view that there is no guarantee of equal interval so

Likert scale should be treated as both ordinal and interval data in educational research and should be referred to as quasi-interval. In this study, the Likert scale was treated as interval data.

According to [22] (p. 521), "with every research design, instruments chosen for the collection of data must pass the tests of validity and reliability before they can be considered good measures". The questions of reliability and validity are essential in any research as the credibility of a research study depends on the reliability of the data, methods of data collection and also on the validity of the findings ([17]; [46]; [64]). The reliability of items is achieved when it consistently, and without bias, measure the concepts/constructs it is supposed to measure [65]. Also, according to [20] the reliability of data obtained through for instance questionnaire rests, in large part, on the uniform administration of questions and their uniform interpretation by respondents. [30] cautioned that it is possible to design a questionnaire that is reliable because the responses are consistent, but may be invalid because it fails to measure the concept it intended to measure.

Following [23] methodology, two (2) experts in the field of ICT integration and mathematics education at the Department of Mathematics Education in the UEW evaluated the questionnaire items for content and construct as well as face validity. A number of discussions took place regarding the questionnaire items, both at the inception and throughout the revision of the questionnaire instrument. Based on feedback from the experts, several changes were made to the questionnaire instrument. Having experts review the questionnaire instrument to confirm that the items were complete, relevant, and arranged in a suitable format was important to establish an adequate level of content validity [8]. According to [8] validity necessitates that the items adequately measure the proposed constructs and that, respondents correctly interpret what each item is asking, so piloting of the instruments was essential.

Piloting of the questionnaire was conducted on 58 preservice mathematics teachers who did not take part in the main study. Out of the 58 preservice mathematics teachers, 3 took part in the think-aloud pilot. The remaining 55 preservice mathematics teachers took part in the questionnaire pilot study. Though content, construct and face validity can be confirmed by having instruments reviewed by experts, construct validity can also start to be verified by means of a think-aloud approach by allowing respondents (who would not take part in the main study) to verbalize their thought and perception about research instruments ([15]; [23]; [29]; [36]; [44]). According to [36], in think-aloud technique, respondents are allowed and asked to verbalize their thoughts and perceptions about the research instrument(s) and the researcher would write down every single thing about respondents' opinions. The think-aloud technique helped the researcher to determine if the respondents get the same interpretation about the items in the questionnaire. In this study, through the think-aloud approach, three preservice mathematics teachers who were not part of the sample were allowed and asked to verbalize their thoughts and perceptions about items on the questionnaire and the researcher penned down every single thing about the respondents' opinions. Responses from the respondents were compared from one person to the other to make sure that the questions are being interpreted in the same way, are easy to understand, and are arranged in a logical sequence [8]. After the think-aloud technique, there were some changes made to the questionnaire.

Pilot testing of a questionnaire on 25-75 respondents is reasonable [18]. According to [18], 25-75 are normally valuable pilot testing range which can vary first with the experience and the talent of the researcher. In this study, the questionnaire was tested by distributing it to a group of fifty-five (55) preservice mathematics teachers who were not part of the main study.

The response rate for the questionnaire pilot study was 100% (55 respondents). The testing of the questionnaire was to check for internal consistency. Scales and tests that involve summing items are evaluated for internal consistency [57]. The most widely approach used in checking the internal consistency of a questionnaire is the calculation of the coefficient alpha or Cronbach's alpha [57]. Cronbach's alpha is mostly used when the research being carried out has multiple-items measuring a concept ([34]; [72]). In this study, Cronbach's alpha (α) (or coefficient alpha) was used, based on the feedback of the pilot group, to measure the internal consistency and reliability of the questionnaire. Cronbach's alpha is interpreted as the percentage of variance an observed scale would explain the hypothetical true scale composed of all possible items in the universe. Unidimensionality which is a fundamental assumption of Cronbach's alpha that assumes the questions are only measuring one latent variable or dimension was taken into consideration before the coefficient alphas were calculated. Cronbach's alpha usually expressed as a number between 0.0 and 1.0 ([34]; [72]). When α equals 0.0, the true result (score) is not measured at all and there is only an error component or a value of 0.0 means no consistency in measurement [34]. When α = 1.0, all items measure only the true score and there is no error component or a value of 1.0 indicates perfect consistency in measurement [34]. Therefore, the closer α is to 1, the greater the internal consistency of the items. Coefficient alpha can be written as a function of number of items and the average inter- correlation among the items. The formula used to calculate the standardized Cronbach's alpha is: $= \frac{N.\bar{c}}{\bar{v}+(N-1).\bar{c}}$, where N is the numbers of items, $\bar{c}$ the average covariance between item-pairs, and $\bar{v}$ is the average variance [71]. From the Cronbach's alpha formula, if the number of items increases, Cronbach's alpha increases. As the average inter-item correlation is low, coefficient alpha will be low. As the average inter-item correlation increases, coefficient alpha increases as well [71]. Intuitively, if the inter-item correlations are high, then there is evidence that the items are measuring the same underlying construct or latent variable [34]. The value one gets for α usually indicates the percentage of the reliable variance. For instance, if one gets a value of .70, it means that 70% of the variance in the scores is reliable variance, which means that 30% is error variance [34]. The acceptable range is between 0.70 and 0.90 or higher depending on the type of research [34]. Similarly, [31] provide the following rules: "(α > 0.9 (Excellent), α > 0.8 (Good), α > 0.7 (Acceptable), α > 0.6 (Questionable), α > 0.5 (Poor), and α < 0.5 (Unacceptable)" (p. 231). Also, a rule of thumb for interpreting alpha for Likert scale questions is: $\alpha \geq 0.9$ (Excellent). $0.9 > \alpha \geq 0.8$ (Good), $0.8 > \alpha \geq 0.7$ (Acceptable), $0.7 > \alpha \geq 0.6$ Questionable), $0.6 > \alpha \geq 0.5$ (Poor), $0.5 > \alpha$ (Unacceptable) (Statistics How To, 2017). There is still debate among researchers as to where the appropriate cut-off points are for coefficient alpha. Combing the literature, [33] also have the following guide: 0.90 and above shows excellent reliability, 0.70 to 0.90 show high reliability, 0.5 to 0.79 shows moderate reliability and 0.50 and below shows low reliability.

For items addressing PK (questions 35 – 41), Cronbach's Alpha was 0.876. For items addressing TK (questions 42 – 47), Cronbach's Alpha was 0.924. For items addressing CK (questions 48 – 50), Cronbach's Alpha was 0.883. For items addressing TCK (questions 51 – 54), Cronbach's Alpha was 0.917. For items addressing PCK (questions 55 – 59), Cronbach's Alpha was 0.845. For items addressing TPK (questions 60 – 67), Cronbach's Alpha was 0.960. For items addressing TPACK (questions 68 – 70), Cronbach's Alpha was 0.860. The Cronbach's alphas were computed with the help of the IBMSPSS version 26.0. The questionnaire was administered personally to help improve the collection and response rate of the questionnaire. The questionnaire was collected as soon as it was filled by the respondents and no communication between respondents was allowed during the filling of the questionnaire. The responses were provided individually by the selected sample. The questionnaire response rate was 125 (100%).

Descriptive measures including mean and standard deviation for items under the PK, TK CK, TCK, PCK, TPK, and TPACK constructs as well as descriptive statistics of TPACK and its component constructs were calculated/generated using IBMSPSS. The Pearson's product-moment correlation was used to determine the relationship among preservice mathematics teachers' ratings of their knowledge levels along the TPACK framework.

Permission was obtained from the students of the department of mathematics education of UEW before the commencement of the study and anonymity of the respondents was protected. The purpose of the study was also communicated to the respondents after which each group representative signed a consent form on behalf of each group. In all, four representatives signed the consent form. The researcher was responsible for maintaining confidentiality [53]. The confidentiality of information provided by all respondents were protected by reporting only group data without any major form of identification.

4. RESULTS AND DISCUSSION

Results are presented under the following subheadings.

4.1 Preservice mathematics teachers perceived knowledge levels on TPACK and its components

To find out preservice mathematics teachers perceived knowledge level in relation to TPACK and its components, the respondents responded to thirty-six items along the areas of technology, pedagogy, content, and the combination of these areas. The average mean for all items (item 35-70) was 3.43. The range of responses was 4, with a minimum response of 1, a maximum response of 5, and a standard deviation of 0.708. The number of respondents, mean, and standard deviation are reported for each item in Table 2 and for each domain/construct in Table 3.

Three dimensions categorisation by [79] as low, moderate and high were used to interpret the findings of preservice mathematics teachers' perception of TPACK levels. According to [79], if mean scores are between 1 and 2.33, the level of perception is considered as "low". If mean scores are between 2.34 and 3.67, the level of perception is considered as "moderate". If mean scores are between 3.68 and 5.00, the level of perception is considered as "high".

Preservice mathematics teachers responding to the questionnaire rated their perceived knowledge as high for the domain of CK (M = 3.72). This average mean score indicate that the preservice mathematics teachers reported that their knowledge is high related to for example: their ability to use a mathematical way of thinking. The highest rated individual item also fell within the category of CK, sufficient knowledge about mathematics with an average response of 3.75 (see Table 2). This result suggests that the preservice mathematics teachers claimed that they have sufficient mathematics content knowledge to teach mathematics (especially core mathematics) after they have graduated. Apart from CK, the preservice mathematics teachers rated their perceived knowledge level on the other domains as moderate (see Table 3).

The first three rated domains are CK (M = 3.72), PCK (M = 3.55), PK (M = 3.52). This finding is similar to the finding of [8] and [35] but a little bit different. That is, [8] and [35] studies, the first 3 high rated domains were PK, CK, and PCK whilst in this study it was CK, PCK, and PK. The slight difference might be due to the sample sizes and the setting. For instance, in this study, the sample size was 125 whilst in [8] study, the sample size was 596.

The preservice mathematics teachers responding to the questionnaire felt that their perceived knowledge associated with combining technology, pedagogy, and content, for instance, their ability to teach lessons that appropriately combine mathematics, technologies and teaching approaches was not as strong as their knowledge related to pedagogy and content. The lowest individually scored item fell within the area of TPACK, rating their ability to use technology to predict students' skill/understanding of a particular topic (Item 70) at 3.00 (see Table 2), which translates to a moderate perceived level. When technology was combined with content or pedagogy, scores were 3.30 and 3.36 respectively. These ratings are lower than those associated with pedagogy and content alone, but not as low as the domain of technology by itself. In examining all three domains/constructs together, the preservice mathematics teachers rated their perceived knowledge level at 3.13. In all, the preservice mathematics teachers rated their perceived knowledge level as high and moderate (see Table 3) on TPACK and its components.

Table 2. Summary of Descriptive Statistics of Preservice Mathematics Teachers Perceived Knowledge Level in Relation to TPACK and Its Components items

Item	Subscale	Responses	Mean	Standard Deviation
35	PK	125	3.57	.826
36	PK	125	3.48	.848
37	PK	125	3.53	.867
38	PK	125	3.47	.876
39	PK	125	3.43	.995
40	PK	125	3.42	.900
41	PK	125	3.74	.950
42	TK	125	3.54	.884
43	TK	125	3.54	.894
44	TK	125	3.43	.928
45	TK	125	3.42	.944
46	TK	125	3.23	.993
47	TK	125	3.25	.913
48	CK	125	3.75	.668
49	CK	125	3.70	721
50	CK	125	3.70	.741
51	TCK	125	3.34	.814
52	TCK	125	3.29	.869
53	TCK	125	3.26	.805
54	TCK	125	3.30	.752
55	PCK	125	3.54	.798
56	PCK	125	3.65	.918
57	PCK	125	3.50	.912

Continuation of Table 2

58	PCK	125	3.50	.904
59	PCK	125	3.54	.903
60	TPK	125	3.18	.817
61	TPK	125	3.26	.842
62	TPK	125	3.74	.784
63	TPK	125	3.42	.743
64	TPK	125	3.34	.823
65	TPK	125	3.31	.837
66	TPK	125	3.16	.865
67	TPK	125	3.47	.876
68	TPACK	125	3.22	.799
69	TPACK	125	3.18	.892
70	TPACK	125	3.00	.967

Table 3. Summary of Descriptive Statistics of the domains of TPACK

Domain/Construct	Number of items	Number of Responses	Mean	Standard Deviation
PK	7	125	3.52	.70647
TK	6	125	3.40	.77805
CK	3	125	3.72	.63225
PCK	5	125	3.55	.72707
TCK	4	125	3.30	.67777
TPK	8	125	3.36	.65850
TPACK	3	125	3.13	.77598

4.2 The relationships among the components of TPACK

The relationships among the components of TPACK have been investigated. Pearson product moment correlation analysis was conducted. Statistical tests mostly rely upon certain assumptions about the variables used in the analysis and when these assumptions are not met the results may not be trustworthy ([27]; [54]). Before the Pearson's product-moment correlation coefficients were calculated, the constructs were subjected to the following assumptions ([32]; [47]; [69]; [70]):

1. The variables must be either interval or ratio measurements.

2. The variables must be approximately normally distributed.
3. There is a linear relationship between the two variables. That is the relationship between the variables is approximately linear.
4. Outliers are either kept to a minimum or are removed entirely. That is there are no significant outliers among the data.
5. There is homoscedasticity of the data.

All the five (5) assumptions were met before the data was subjected to Pearson product moment correlation analysis. The Pearson Product-Moment Correlation coefficients among TPACK and its components are shown in Table 4. The examination of Pearson Correlation values indicates that there was statistically significant positive correlation among all of the components of perceived TPACK about mathematics. Moreover, the correlations were significant because they were different from zero in the entire/total population.

Table 4. Pearson product-moment correlations among TPACK and its components

	PK	TK	CK	PCK	TCK	TPK	TPACK
PK	1						
TK	.581**	1					
CK	.664**	.575**	1				
PCK	.728**	.498**	.674**	1			
TCK	.574**	.741**	.553**	.548**	1		
TPK	.607**	.682**	.543**	.634**	.807**	1	
TPACK	.548**	.549**	.547**	.570**	.680**	.775**	1

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

To determine the strength of the relationship, [16] suggests a guideline: if the values of the correlation coefficient range from .10 to .29, there is a small relationship between variables. If the values of the correlation coefficient range from .30 to .49, there is a medium relationship between variables. If the values of the correlation coefficient are above .50, there is a large or strong relationship between variables. Therefore, Table 4 indicates that there were no small relationships; all relationships among TPACK components were medium and large/strong. These strong correlations confirm similar findings by [8].

The highest correlation was between TCK and TPK at $\alpha = .01$ with $r = .807$, $P = .000$. The second highest correlation was between TPACK and TPK at $\alpha = .01$ with $r = .775$, $P = .000$. The third highest correlation was between TPK and TK at $\alpha = .01$ with $r = .682$, $P = .000$. On the other hand, the smallest correlation was between TK and PCK at $\alpha = .01$ with $r = .498$, $P = .000$. The r values corresponding to the remaining correlations range from .543 to .680.

Within the current study, the preservice mathematics teachers reported TPACK knowledge levels were highest specific to items related to CK, PCK and PK and they were found to be the top three rated knowledge levels. This outcome may be due to a number of factors, such as how preservice mathematics teachers were taught from the pre-tertiary level through to the university level. It could also suggest that the preservice mathematics teachers may have been best prepared with regard to content and pedagogy and this, together with their pre-internship course that gave them the experience of peer teaching, led to the high ratings of knowledge along these same domains. The highest mean value of preservice mathematics teachers' perceptions was content knowledge and this could mean that preservice mathematics teachers feel more competent and sophisticated related to mathematics knowledge among TPACK components. On the other hand, the least mean values of preservice mathematics teachers' perceptions correspond to TCK and TPACK. It is likely the preservice mathematics teachers do not feel themselves competent and sophisticated in knowledge that combine technologies and teaching approaches in teaching mathematical concepts.

The findings in this study are similar to or consistent with the findings from some studies ([8]; [12]; [14]; [24]; [25]; [26]; [35]; [38]; [13]; [55]; [60]; [74]; [78]). For instance, [60] findings show that preservice mathematics teachers' ratings on technology use was not high. Also, [35] found that preservice mathematics teachers' ratings were high on pedagogy, content, and pedagogical content. [14] stated that in their study, preservice mathematics teachers had high level perceptions on some TPACK sub-domains and [8] findings indicated that knowledge ratings are high among the domains of pedagogy, content, and pedagogical content. [12] also found highest mean value corresponding to CK and least mean value corresponding to TCK.

Similarly, [26] found that mathematics teacher candidates have low TCK. In trying to develop preservice mathematics teachers TPACK levels, some studies (e.g., Agyei & Voogt, 2012) tried pre-test and post-test approaches. Per [79] categorisation, the pre-test results in Agyei and Voogt's (2012) study showed moderate and high knowledge levels on TPACK and its components and high levels on TPACK and its components for the post-test results. Results from this study showed that preservice mathematics teachers' TPACK and its components could be developed via training in how to integrate appropriate technologies with sounding teaching approaches in teaching concepts.

Furthermore, the results indicate that there are positive relationships among the components of TPACK, and all of the relationships are statistically significant. Results of other TPACK studies support the findings of the present study. As an example, in [59] study, statistically significant correlations were found among the all dimensions of TPACK. Additionally, [73] have found high relationship between the TPACK, TPK, TCK, and TK components. Considering the findings from the present study, literature suggest that CK, PK and TK should be treated together and not separately ([41]; [51]; [59]). Besides, [40] state that "quality teaching requires developing a nuanced understanding of the complex relationships among technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representation (p.1029)". Therefore, it can be claimed that the present study supports the intertwined relationship among CK, PK and TK as stated in the literature as well as TPACK correlational studies. Finally, this study has contributed to [40], [40] theory of Technological Pedagogical Content Knowledge (TPACK).

5. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings made in this study, it can be concluded that preservice mathematics teachers' TPACK levels could be moderate or high if they are taken through how to integrate technologies interspersed with pedagogies in the teaching and learning of concepts in mathematics. The findings of this study, therefore, are generalizable to the preservice mathematics teachers of UEW in particular, and to similar institutions elsewhere in Africa and other developing countries. Furthermore, based on the findings in this study, it is recommended that the preservice mathematics teaches perceived knowledge level in terms of TPACK and its components should be maintained as high for CK and the rest improved to high so that they can integrate technologies/ICTs into the teaching and learning processes after they have graduated.

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