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Technology in Teaching and Learning at the Basic School: A TPACK Report on Teachers at Aman from Ngleshie Cluster Basic Schools in the GA South Municipality of Ghana

Divine Atinyo
Researcher, Department of Finance, School of Business,
University of Cape Coast, Cape Coast, Ghana
Calvis Wonder Creppy
Student, Department of English,
University of Cape Coast, Cape Coast, Ghana

Abstract:
Technology has become part of the education system as it has contributed in several ways to improve teaching and learning in basic schools. However, basic schools in the Ga South, particularly, Amanfrom Ngleshie, seem to be behind time in the use of ICT. This study, thus, assessed teachers' TPACK capacity to integrate technology into the curriculum (teaching and learning) of basic schools in Ghana. The study employed the quantitative method and used the correlational design. A total of 103 out of 139 teachers from 11 basic schools were sampled, using the proportionate random sampling techniques. Statistical tools of mean, standard deviation and Pearson product-moment coefficients were used for data analyses. The results showed that teachers have high technological knowledge. It was also revealed that the teachers have appreciable pedagogical knowledge. Further, it was found that the teachers have very high content knowledge. Finally, significant positive relationships were found among technological, pedagogical and content knowledge components of TPACK, and their dyadic subscales or intersections. It was concluded that teachers have the capacity, as far as TPACK is concerned, to integrate technology into curriculum andthe general education system in Ghana. It was recommended that science and technology be incorporated into the curricula of colleges of education and universities, and be studied throughout a potential teacher's study period. Suggestions were also made for further studies.

Keywords: *TPACK, teaching and learning, basic school, Amanfrom Ngleshie Cluster*

1. Introduction

Advancement in technology has had impact on every aspect of life. The 21st century has shown that digital revolution is at its crescendo;transmission and dissemination of information has become very swift and convenient. Also, globally, this century is associated with better, innovative and improved ways of communication. Teaching and learning in various technologically inclined institutions has also been improved (Gongden, &Gongden, 2019). All these plausible impacts have been possible due to technology, and particularly, the advent of the computer – bringing into existence a new dawn for global development. For the time being, technology can only be seen to continue to get more sophisticated, as the world is witnessing the invention of new technologies at every point in time (Voogt, &McKenney, 2017).

Though many scholars have alluded to the importance of technology in teaching and learning,with respect to teachers' technological, pedagogical and content knowledge (TPACK) (Hilton, 2016; Voogt, &McKenney, 2017), many of the prior studies focused on teachers in developed economies such as the United States of America(Manches, Phillips, Crook, Chowcat, &Sharples, 2010; DiNardo, 2010; Ghavifekr, &Rosdy, 2015; Wulansari, Adlim, &Syukri, 2020). Thus, developing and middle-income economies, such as Ghana which is the focus of the current study, lack empirical literature on teachers' TPACK – particularly, basic schoolteachers (Atteh, Assan-Donkoh, Ayiku, Nkansa, & Adams, 2020).

Also, it should be mentioned that, to facilitate ICT integration into an education system, teachers' TPACK cannot be overemphasised. Nevertheless, to the best of knowledge of the researcher, no study has yet assessed the TPACK of basic school teachers in Ghana, as many previous related studies conducted in Ghana only considered challenges faced by teachers in the use of computers (Atteh et al., 2020; Agyemang, &Mereku, 2015; Sarfo, Amartei, Adentwi, &Brefo, 2011).Meanwhile, studies conducted elsewhere revealed that most of the challenges teachers encounter in the use of ICT are related to technological knowledge, pedagogical knowledge and content knowledge (Ghavifekr, &Rosdy, 2015; Wulansari et al., 2020; Hilton, 2016) – though these studies considered teachers other than basic school teachers.

Considering these gaps in literature, the researcher deemed it important to assess the technological knowledge, pedagogical knowledge and content knowledge of teachersin the use of ICT in curriculum at the AmanfromNgleshie Cluster of basic schools in Ga South Municipality of Ghana, as well as to analysethe relationships among the teachers'

technological knowledge, pedagogical knowledge and content knowledge. This study, apart from expanding knowledge on teachers' TPACK and contributing to literature, would make a wealth of information needed to expedite integration of technology (ICT) into teaching and learning available to the Ghanaian government, the Ghana Education Service (GES), basic education policymakers, education-oriented non-governmental organisations, head of schools, teachers and students, among others. This wealth of information would help these stakeholders to get grasp of challenges or otherwise, related to TPACK, faced by basic school teachers, so that the necessary policies could be formulated to ensure that the required resources are made available to the basic school teachers in order to facilitate technology integration into the basic education system to improve teaching and learning.

2. Literature Review

This study was underpinned by the technological pedagogical and content knowledge (TPACK) model by Mishra and Koehler (2006). The TPACK model conceptualizes the knowledge required by teachers to appropriately teach with ICT.Additionally, this model considers effectual integration of ICT into teaching and learning; thus, this model is considered useful in explaining the kind of knowledge needed by teachers to effectively incorporate technology into their teaching activities, surmount challenges, and put appropriate measures in place to enhance practices of teaching and learning (Voogt, &McKenney, 2017; Voogt, Fisser, Roblin, Tondeur, & van Braak, 2013).Further, it could be said that if teachers put right measures in place, and stakeholders in education produce technology-rich TPACK-based curriculum for the basic school system, integration of ICT facilities would be enhanced.

Literature abounds on integration of ICT into teaching and learning. For instance, Agyemang and Mereku (2015) looked at Pan-African agenda on pedagogical integration of ICT into education with a specific focus on how to use ICT to improve teachers' lesson delivery in the classroom. They used teachers and education practitioners as the study participants, employing the qualitative approach. It was revealed that web-based approach where CD-ROMs, electronic journals, online sources of materials, among others are the ways teachers employ to facilitate teaching and learning through ICT integration. Also, Sarfo et al. (2011) investigated how ready teachers are to embrace technology and how to engage learners to enhance ICT integration into education process. Using the qualitative approach, Sarfo et al. found that many teachers were not fully ready for the transition. However, teachers who showed readiness said they would make recordings of lessons on disks and drives for their students in order to promote teaching and learning through ICT.

Further, employing the descriptive statistics, and using teachers from Northern Sierra Leone district of Koinadugu as the study participants, Samarakoon, Christiansen and Munro (2017) examined how TPACK can assist in integrating ICT into education practices. The results of their study showed that, on the average, teachers' pedagogical knowledge was high; knowledge in the use of ICT was high, and knowledge in content was also high. They concluded that the teachers were ready for technology integration into education. Similarly, Hennesey, Onguko, Harrison,Ang'ondi, Namalefe, Naseem and Wamakote (2010), using review approach, assessed the use of information and communication technology to enhance teaching and learning in East African schools. The findings showed the teachers to have high level of knowledge in technology, pedagogy and content; hence, placing them in the right position to champion ICT integration into education.

In another study, Badau and Sakiyo (2013) examined the competence level of rural and urban secondary school ICT teachers for the implementation of ICT curriculum in the North Eastern of Nigeria. The findings revealed knowledge level of teachers on pedagogy, technology, administration and professionalism to be low. The authors then recommended that ICT be incorporated in the early development teachers during their preservice training periods. Wulansari et al. (2020) also investigated technological pedagogical and content knowledge (TPACK) of science teachers in suburban areas in Indonesia. Using 71 teacher, and employing statistical tools of ANOVA and the independent t-test, technological knowledge was found to be average among the teachers; pedagogical knowledge was low, and content knowledge was average.

To investigate the associations among technological, pedagogical and content knowledge, Doukakis, Koilias, Adamopoulos and Giannopoulou (2011), using the correlational design and 1023 teacher respondents from upper education in Greece, found a positive relationship between technological knowledge and pedagogical knowledge, and content knowledge. Also, the individual constructs had positive associations with technological pedagogical and content knowledge (TPACK). The implication was, as teachers' knowledge increase in the individual components of TPACK, their overall competence in the combinations of the individual knowledge areas also increases. In a similar study, Fisser, Voogt, van Braak and Tondeur (2016) measured and assessed technological pedagogical and content knowledge (TPACK) of teachers. Findings indicated that technological knowledge, pedagogical knowledge and content knowledge were significantly correlated to one another. Combinations of the knowledge areas also showed positive correlations.

As could be seen in the foregoing review, in most of the cases, technological knowledge, pedagogical and content knowledge were considered separately in separate studies (Mereku et al., 2011; Sarfo et al., 2011; Badau, &Sakiyo, 2013); meaning, different set of participants were considered in each case, making it difficult to conclude whether the outcomes in each case applies to other teacher participants in other studies. Thus, to contribute to resolving this confusion, and to fill the lacuna in literature, the current study used the same set of teachers as respondents across all the components of TPACK. Also, even studies which considered the same set of participants across the three TPACK components (Samarakoon et al., 2017; Hennesey et al., 2010; Wulansari et al., 2020; Doukakis et al., 2011; Fisser et al., 2016) focused on teachers other than basic school teachers, and these studies were conducted outside the current study locale. These lacunae made the current study relevant to literature as it sought to fill these gaps by reporting on basic school teachers' TPACK, in the light of technology integration into teaching and learning in Ghana.

3. Materials and Methods

This study was quantitative in nature. Also, the correlational design was employed as the study sought toexamine relationships between constructs (Garson, 2012; Creswell, 2013), among other things.Employing the sample size formula for finite population proposed by Krejcie and Morgan (1970) and the proportionate random sampling technique, 103 basic school teachers from 11 basic schools in the AmanfromNgleshie Cluster in the Ga South Municipality of Ghana were selected from a total population of 139 basic school teachers. A structured TPACK survey instrument adapted from Schmidt, Baran, Thompson,Mishra, Koehler and Shin(2009) was used for data collection. The instrument had two sections –Section A solicited data on socio-demographic information of study participants, and Section B collected responses to the TPACK subscale items. The subscales were technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), pedagogical content knowledge (PCK), and technological pedagogical and content knowledge (TPACK).

The items on the subscales were measured on a 5-point likert scale, ranging from strongly disagree (1) to strongly agree (5). Technological knowledge (TK) contained 15 items, pedagogical knowledge (PK) had six (6) items, content knowledge (CK) contained six (6) items, technological pedagogical knowledge (TPK) had four (4) items, technological content knowledge (TCK) had seven (7) items, pedagogical content knowledge (PCK)also contained four (5) items, and technological pedagogical and content knowledge (TPACK) had five (5) items. It should be mentioned that the scales were tested for reliability, and the Cronbach's coefficients obtained are as follows: TK (14 items), 0.965; PK (6 items), 0.972; CK (5 items), 0.964; TPK (3 items), 0.965; PCK (7 items), 0.970; TCK (3 items), 0.954; TPACK (5 items), 0.961. Statistical tools used for the analysis included frequencies, percentages, mean, standard deviation and the Pearson product-moment correlation coefficients.

4. Results

This section presents the results of the study. Table 1 shows the socio-demographic information of the teachers; Table 2 presents results for the first research question – What is the technological knowledge of teachers in the use of ICT in curriculum?; Table 3 shows results for the second research question – What is the pedagogical knowledge of teachers in the use of ICT in curriculum?; Table 4 displays results for the third research question – What is the content knowledge of teachers in the use of ICT in curriculum?; and finally, Table 5 shows the linear relationships between the constructs – TK, PK, CK, TPK, TCK, PCK, and TPACK.

4.1. Socio-Demographic Information of Teachers

This presents gender, teaching experience, academic qualification, and whether teacher had had training in ICT. Frequencies and percentages were used for the analysis.

Responses	Sub-scale	Frequency	Percent
Gender	Male	49	47.6
	Female	54	52.4
Teaching experience (in years)	<5	58	56.3
	5-10	15	14.6
	11-15	2	1.9
	16-20	11	10.7
	>20	17	16.5
Academic qualification	Certificate	1	1.0
	Diploma	36	35.0
	Bachelor's degree	59	57.3
	Master's degree	7	6.8
Had ICT training	No	36	35.0
	Yes	67	65.0

Table 1: Socio-Demographic Information
Source: Field Survey (2021)
N = 103

The results showed that 49 (47.6%) of the teachers are males whilst 54 (52.4%) ofthem are females. Teaching experience ranged from less than 5 years (58, 56.3%) to above 20 years (17, 16.5%). The least qualification was a Certificate (1, 1.0%) and the highest was Master's degree (7, 6.8%), with majority of the teachers holding Bachelor degree (59, 57.3%). When the teachers were asked whether they had had training in ICT or not, 67 (65.0%) responded that they had had a training in ICT whilst 36 (35.0%) said they had not had ICT training.

4.2. Technological Knowledge of Teachers

The results on the technological acknowledge of teachers are shown here. Average score of (>3.0) indicates overall agreement to a statement and hence appreciable technological knowledge of teachers in the use of ICT. On the other hand, a mean score of (3.0 ≥) shows overall disagreement to a statement; hence, little to no technological knowledge of teachers in the use of ICT curriculum.

Statement	Mean	SD
Knowledge in solving technical problems	3.05	1.451
Knowledge about basic computer hardware	3.44	.925
Knowledge in basic computer software	3.81	.875
Knowledge in following recent computer technologies	3.60	.994
Knowledge in using a word-processor programme	3.73	.941
Knowledge in using an electronic spreadsheet programme	3.61	.931
Knowledge in communicating through internet tools	3.93	.877
Knowledge in using a picture editing programme	3.44	.987
Knowledge in using a presentation programme	3.66	1.005
Knowledge in saving data into a digital medium	3.56	.836
Knowledge in using area-specific software	3.41	.985
Knowledge in using printer	3.61	.921
Knowledge in using projector	3.35	1.126
Knowledge in using scanner	3.47	1.101
Knowledge in using digital camera	3.62	.887
Overall technological knowledge	3.55	.989

Table 2: Technological Knowledge
Source: Field Survey (2021)
N = 103

From the results presented in Table 2, on the average, all the teachers at the Amanfrom Ngleshie Cluster of basic schools had knowledge in all the indicators defining technological knowledge, as all the mean scores were above 3.0. This was further confirmed by the average score shown for overall technological knowledge (M = 3.55±0.989SD).

4.3. Pedagogical Knowledge of Teachers

The results onpedagogical acknowledge of teachers are shown here. Average score of (>3.0) indicates overall agreement to a statement and hence appreciable pedagogical knowledge of teachers in the use of ICT. On the other hand, a mean score of (3.0 ≥) shows overall disagreement to a statement; hence, little to no pedagogical knowledge of teachers in the use of ICT curriculum.

Statement	Mean	SD
Knowledge in assessing student performance	4.05	1.004
Knowledge in dealing with and eliminating individual differences	4.02	1.075
Knowledge in using different evaluation methods and techniques	3.87	1.117
Knowledge in applying different learning theories and approaches	3.84	1.118
Aware of possible student learning difficulties and misconceptions	3.97	1.089
Knowledge in managing class	4.05	1.042
Overall pedagogical knowledge	3.97	1.074

Table 3: Pedagogical Knowledge
Source: Field Survey (2021)
N = 103

From the results shown in Table 3, on the average, all the teachers at the Amanfrom Ngleshie Cluster of basic schools had knowledge in all the indicators defining pedagogical knowledge, as all the average scores were above 3.0. This was further affirmed by the average score shown for overall pedagogical knowledge (M = 3.97±1.074SD).

4.4. Content Knowledge of Teachers

Results on content acknowledge of teachers are shown in Table 4. Average score of (>3.0) indicates overall agreement to a statement and hence appreciable content knowledge of teachers in the use of ICT. On the other hand, a mean score of (3.0 ≥) shows overall disagreement to a statement; hence, little to no content knowledge of teachers in the use of ICT curriculum.

Statement	Mean	SD
Knowledge in knowing about key subjects in my area	4.30	1.420
Knowledge in developing class activities and projects	4.43	1.273
Knowledge in following recent developments and applications in my content area	4.36	1.399
Knowledge in recognising leaders in my content area	4.39	1.308
Knowledge in following up-to-date resources	4.39	1.374
Knowledge in following conferences and activities in my content area	4.05	1.389
Overall content knowledge	4.32	1.361

Table 4: Content Knowledge
Source: Field Survey (2021
N = 103

From the results displayed in Table 4, all the teachers at the Amanfrom Ngleshie Cluster of basic schools had knowledge in all the indicators defining content knowledge, as all the mean scores were above 3.0. This was further affirmed by the average score shown for the overall content knowledge (M = 4.32±1.361SD).

4.5. Linear Relationships among Technological, Pedagogicaland Content Knowledge, and Their Intersections

Using the Pearson correlation, the bivariate relationships between TK, PK, CK, and their intersections were analysed. The results are shown in Table 5.

Constructs		TK	PK	CK	TPK	PCK	TCK	TPACK
TK	r	1	.560**	.518**	.647**	.497**	.533**	.552**
	p		.000	.000	.000	.000	.000	.000
PK	r	.560**	1	.922**	.395**	.764**	.358**	.452**
	p	.000		.000	.000	.000	.000	.000
CK	r	.518**	.922**	1	.334**	.721**	.280**	.351**
	p	.000	.000		.001	.000	.004	.000
TPK	r	.647**	.395**	.334**	1	.385**	.687**	.808**
	p	.000	.000	.001		.000	.000	.000
PCK	r	.497**	.764**	.721**	.385**	1	.513**	.460**
	p	.000	.000	.000	.000		.000	.000
TCK	r	.533**	.358**	.280**	.687**	.513**	1	.809**
	p	.000	.000	.004	.000	.000		.000
TPACK	r	.552**	.452**	.351**	.808**	.460**	.809**	1
	p	.000	.000	.000	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed)								

Table 5: Correlation among TK, PK, CK and intersections
Source: Field survey (2021)
N = 103

From the results presented in Table 5, it could be seen that the correlation between the constructs varied from a coefficient of 0.280 (TCK and CK) to a coefficient of 0.922 (PK and CK). It was also evidenced that all the linear relationships between the constructs, bivariate-wise, were positive and significant.

5. Discussion

Considering the first research question, the findings, as shown in Table 2, showed that teachers at the Amanfrom Ngleshie Cluster basic schools understood technology and had appreciable knowledge in the use of ICT in curriculum to enhance integration of technology into the educational system in Ghana. This implied that teachers in these basic schools could competently use computers and accessories to improve teaching and learning. This level of knowledge, as far as the TPACK framework is concerned, is the first layer of competence expected to be achieved by teachers in order to integrate technology into education (Mishra, & Koehler, 2006). This means that these basic school teachers could contribute substantially to the ICT integration into education. This finding was consistent with Mereku et al. (2011) which indicate teachers to have knowledge in technological facilities used to facilitate teaching and learning.

On the contrary, this finding did not correlate the findings of Sarfo et al. (2010) who find that teachers have little to no knowledge in technology and, therefore, are not ready for full technological transition. However, Sarfo et al. also appreciated the fact that few of the teachers could make recordings of topics discussed in class available on disks or drives for learners to have access to. The researcher, on the other hand, was not surprised the teachers have appreciable knowledge in the use of technology. The researcher ascribed this to the proliferation of technological gadgets such as mobile phones, cameras, scanners, laptop computers and projectors among others in this 21st century which make learning of new things easy for those who can read and write, and since these teacher participants could read and write, it was not surprising they had, on the overall, an appreciable technological knowledge. Also, the teachers' socio-demographic information on training in ICT revealed that majority of the teachers had training in ICT (67 out of 103, representing 65.0%) – this affirmed why the teachers had hightechnological knowledge in the use of ICT.

The findings to the second research question also showed that teachers at the Amanfrom Ngleshie Cluster basic schools understand pedagogy and have substantial pedagogical knowledge in the use of ICT in curriculum to enhance integration of technology into the educational system in Ghana. This implies that teachers in the basic schools can competently utilise their pedagogical knowledge to improve ICT use in the basic schools in Amanfrom Ngleshie Cluster and in Ghana at large. This finding is consistent with the finding of Hennesey et al. (2010) which revealed teachers to have demonstrated pedagogical knowledge in the use of technology, and thus, matching up the TPACK model. However, the finding does not correlate with the finding of a similar study conducted in Nigeria by Badau and Sakiyo (2013) which found teachers to have very low pedagogical knowledge; therefore, impeding academic administration and professionalism as far as technology integration into education is concerned. The researcher, however, was of the view that since majority of the teachers at the Cluster basic schools had bachelor's degree or diploma in education – as shown in Table 1 – they might have already been exposed to issues of pedagogy.

Further, the findings revealed that teachers at the Amanfrom Ngleshie Cluster basic schools have substantial content knowledge in the use of ICT in curriculum to enhance integration of technology into the educational system in Ghana. This is to say that teachers in the basic schools can intelligently utilise their content knowledge to improve ICT use in the basic schools in Amanfrom Ngleshie Cluster and in Ghana, in general. The finding supports the findings of Hennesey et al. (2010), Wulansari et al. (2020) and Samarakoon et al. (2017) who found teachers to have appreciable content knowledgeas far as technology is concerned. According to the researcher, this finding was not surprising as the teachers had had education and training at the college, which was expected to boost their content competence to help enhance technology-education integration in a holistic manner.

Finally, the findings showed positive significant relationships among the three main components of TPACK – technological knowledge, pedagogical knowledge and content knowledge, and their intersections. This finding implies that if teachers' knowledge in one of the TPACK components is improved, their knowledge in the other components is likely to improve. Thus, a focus on, say, pedagogy may result in improvement in technological, pedagogical and content knowledge, leading to facilitation of technology integration into education. This finding corroborates the findings of Doukakis et al. (2011) and Fisser et al. (2016) who also found a statistically significant positive association among the TPACK components. This finding, according to the researcher, did not come as a surprise as the foregoing findings had already shown that the teachers were competent in each of the TPACK areas of technology, pedagogy and content.

6. Conclusion

The findings of this study demonstrated that the teachers at the basic schools within the Amanfrom Ngleshie Cluster had the requisite competence in TPACK to facilitate technology or information and communication technology into the education system in Ghana. The findings were also in corroboration with findings of many studies done outside the current study area (Hennesey et al., 2010; Wulansari et al., 2020; Samarakoon et al., 2017). It can, therefore, be concluded that TPACK can be employed as a tool to assess teachers' readiness towards integration of information and communication technology into an education system, as this study has provided a strong evidence of the usefulness of TPACK in incorporating technology into education.

In the light of the findings revealed in this study, recommendations were made for government, Ghana Education Service and basic school teachers. Government should incorporate science and technology into the curriculum of colleges of education and universities, and be studied throughout a potential teacher's stay at the college or university. For the Ghana Education Service, they should institute on-the-job training programmes in ICT in all basic schools for teachers to upgrade their knowledge in technology in order to encourage them to embrace technological changes; these programmes should cover all spheres of TPACK, including content, pedagogy and technology. Further, the individual teachers should make efforts by using their personal gadgets to explore the internet for information on TPACK and how they can acquire the needed knowledge in order to enhance teaching and learning. Having confirmed the usefulness of TPACK in assessing teachers' knowledge levels in various areas for facilitating technology integration into teaching and learning, using basic school teachers, future studies can be conducted using teachers at advanced levels of our education – such as senior high schools, and universities, among others.

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