

Science Teachers' Technological Pedagogical Content Knowledge Acquisition in Calabar Education Zone of Cross River State, Nigeria

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Abstract

This study adopted survey design to examine science teachers' technological pedagogical content knowledge acquisition. It was guided by two research questions and two null hypotheses. All the four hundred and six (406) science teachers were used as sample for the study. One instrument titled "Science Teachers' Technological Pedagogical Content Knowledge Questionnaire" (STTPCKQ) was used for data collection. The reliability of the questionnaire, established using Cronbach Alpha, ranges from .78 to .83. The hypotheses were tested using population t-test for hypothesis one and independent t-test for hypothesis two. The two hypotheses were tested at .05 level of significance. The findings of the study revealed that science teachers' technological pedagogical content knowledge acquisition is significantly high and there is a significant influence of gender on Science Teachers' Technological Pedagogical Content Knowledge (TPACK) acquisition in public Secondary Schools. Based on the findings of this study, it was recommended, amongst others, that workshops, conferences and seminars should be organised regularly for secondary school teachers to sustain and/or maintain the high level of technological pedagogical content knowledge they claimed to have achieved.

Keywords: content, knowledge, pedagogical, technological, gender

Introduction

The 21st century is marked by the rapid development of information and communication technology (ICT). The integration of Information and Communications Technology (ICT) in classrooms has been a challenge for the educational systems that aim to cope with the needs and the demands of the 21st century. The Technological Pedagogical Content Knowledge (TPACK) framework represents the knowledge needed by teachers bringing together content knowledge, technological knowledge and pedagogical knowledge with the aim of integrating ICTs into teaching-learning processes. For a science teacher to be

effective and efficient in teaching, he or she must possess relatively fair knowledge of Technological Pedagogical Content Knowledge (TPACK) in helping students understand some content knowledge in science (Ozudogru & Ozudogru, 2019). The interactions between teachers, students, the learning environment, and the learning tasks are influenced by the pedagogical approaches used in the classroom by teachers (Ibok et al., 2019). Effective pedagogy is dependent on the teacher's lesson development strategies, the learners' ability, and the availability of resources. An effective pedagogy develops authentic activities that bring out the best in each learner while also assisting them in improving their learning experiences.

Teaching with technology has become very challenging to teachers. New technologies have inherent properties that make the application in a straight forward way difficult (Gomez-Trigueros & Aldecoa, 2021). The traditional technologies are specific in nature while the new technologies are used in varied ways; for example, computers and hand held devices (Semerci & Aydin, 2018). Since the teaching of science is a complex and difficult task, for teachers to stay up to date, they need to grow professionally. As a science teacher, continuous effort is required towards efficiency in the use of technology for teaching. In classroom teaching, science teachers need to integrate technology into their instructions (Ibok & Unoh, 2019). In order to facilitate the understanding of difficult concepts in the curriculum and create opportunity for testing of facts and theories in learning, incorporation of technology in the teaching of sciences is necessary, to boost collaboration among learners and increase rate of acquiring problem solving skills. Altuni and Akyidi (2017) investigated pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) levels based on different dimension of TPACK and found teachers significantly high in levels of TPACK. Each teacher has different characteristics that influence the learning process that will be carried out. The teacher's variables such as gender could influence effective teaching in schools.

Gender is one of the factors that could influence the teacher's TPACK mastery. Differences in characteristics, attitudes, and abilities by male and female teachers could influence teacher's mastery of teacher TPACK (Ibok, et al., 2023). Liu et al. (2015), in their study surveying Chinese In-Service K12 Teachers' Technology, Pedagogy and Content Knowledge, found that gender was a factor that influences teacher TPACK and that there were significant differences in TPACK towards teacher gender where male have higher TPACK than female. This is due to the males' knowledge of ICT being better than females. According to Berber and Erdem (2015), different ICT knowledge between male and female can affect the mastery of TPACK. Yildiz (2017) investigated the factors affecting techno-pedagogical competencies and critical thinking skills of Pre-service Mathematics Teachers and found no significant technological and pedagogical mastery differences between male and female teachers. Therefore, teacher's mastery of pedagogy, knowledge content, and technology between male and female teachers were same. Semerci and Aydin (2018) examined high school teachers' attitudes towards ICT use in education and found lack of ICT knowledge was the main reason teachers lack confidence in adopting and integrating ICT. The study conducted by Ay et al. (2016) and Ersoy et al. (2016) found that teacher TPACK was not influenced by gender.

The difference in TPACK mastery may be due to a technological gap between males and females getting reduced. Naaz and Khan (2018) conducted a study to find out the level of Technological Pedagogical Content Knowledge (TPACK) of Pre-service teachers. The study also found out the effect of gender and streams on TPACK of teachers. The finding of the study indicates that both males and females differ in Technological Knowledge, but overall TPACK of pre-service teachers have no difference on the basis of gender. Ergen et al. (2018), using meta-analysis method to examine whether there is a significant difference in the effect size of the Technological Pedagogical Content Knowledge (TPACK) according to gender, found that there is a significant difference between the knowledge types about TPACK by gender, and in the sub-group analysis, technology knowledge, technological pedagogical knowledge and technological pedagogical content knowledge have a significant effect size in favour of males; on the other hand, content knowledge, pedagogical content knowledge, and technological content knowledge have an insignificant effect size in favour of male and pedagogical knowledge has an insignificant effect size in favour of females. Ozudogru and Ozudogru (2019) examined survey study on Technological Pedagogical Content Knowledge of Mathematics Teachers and the Effect of Demographic Variables and found Technological Knowledge, Pedagogical Knowledge, Content Knowledge, Technological Content Knowledge, Pedagogical Content Knowledge and TPACK as being significantly high among the teachers. The results also revealed that there were significant differences between gender and technological knowledge domain in favour of male teachers.

Gomez-Trigueros and Aldecoa (2021) conducted a study on the Digital Gender Gap in Teacher Education: The TPACK Framework for the 21st Century. The result show that compared to men, the female participants have a very poor self-perception in terms of their Digital Teaching Competence, as well as a lower predisposition towards technologies. Mai and Hamzah (2016) examined the primary science teachers' perceptions of technological pedagogical content knowledge (TPACK) addressing teachers' perceptions of the affordances of technology application in instruction. TPACK involving the seven factors of technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), as well as synthesized knowledge of technology, pedagogy, and content (TPC). The findings indicate that primary science teachers perceive higher self-confidence in pedagogical knowledge in general. Furthermore, there were no differences between science teachers' perceptions, according to their gender.

Research questions

This study was guided by the following research questions:

- 1) What is the extent of science teachers' Technological Pedagogical Content Knowledge acquisition (TPACK) in public secondary schools?
- 2) To what extent does gender influence science teachers' Technological Pedagogical Content Knowledge (TPACK) in public secondary schools?

Hypotheses

The following null hypotheses were formulated, at 0.05 significant level, to guide the study:

Ho1: The extent of science teachers' Technological Pedagogical Content Knowledge (TPACK) acquisition in public secondary schools is not significantly high.

Ho2: There is no significant influence of gender on science teachers' Technological Pedagogical Content Knowledge (TPACK) acquisition in public secondary schools.

Methodology

The study area was Calabar Education zone of Cross River State, Nigeria. The research design used for this study was the survey design. The researchers used this design because the researchers were able to draw large sample of teachers, describe and examine the extent of science teachers' Technological Pedagogical Content Knowledge (TPACK) acquisition in public secondary schools in Calabar Education Zone of Cross River State, Nigeria. The population for the study consisted of all the secondary school science teachers in Calabar Education Zone of Cross River State which made up of seven (7) Local Government Areas namely: Akamkpa, Akpabuyo, Bakassi, Biase, Calabar Municipality, Calabar South and Odukpani. There are eighty-eight (88) public secondary schools and four hundred and six (406) science teachers which comprises of 205 (50.5%) females and 201 (49.5%) males. Census sampling method was adopted to choose the whole population for this research as sample since the population was small enough to be handled by the researchers.

An instrument was used for data collection; it is titled "Science Teachers' Technological Pedagogical Content Knowledge (TPACK) Questionnaire". The questionnaire comprised two parts, A and B. Part A demanded information on science teachers' demographic data such as sex; while section B was made of 42 items, with 7 items to measure each science teachers' domains of Technological Pedagogical Content Knowledge such as knowledge of technology, pedagogical knowledge, content knowledge, pedagogical content knowledge, technological content knowledge, technology pedagogical knowledge, and technological pedagogical content. The instrument was based on four point Likert Scale of strongly agreed with 4 points, agreed scored 3 points, disagreed scored 2 points, and strongly disagreed scored 1 point. The questionnaire items were constructed by the researchers and was face-validated by two experts in Measurement and Evaluation, and two Science Educators, all from the University of Calabar. Corrections were pointed out by the experts and adjusted by the researchers and the document was considered valid.

The reliability of the questionnaire was established using 50 science teachers in Ikom Education Zone of Cross River State who were not part of the main study but however shared similar characteristics with the study population. After the trial test, Cronbach Alpha method was used and the internal consistency estimates were found to range between .78 and .83. These were adjudged high and guaranteed the use of the instrument for the research. Since the reliability index is above .50, the estimates were considered high enough for the study. The Statistical Package for Social Sciences (SPSS) computer programme was used to analyze the data collected. The hypothesis one was tested using population t-test while hypothesis two was tested using independent t-test.

Presentation of results

The result of the analysis is presented in tables 1 and 2. The hypotheses were tested at .05 significant level.

Ho1: Science teachers' technological pedagogical content knowledge acquisition is not significantly high.

For the Science Teachers’ TPACK to be significantly high, the score on each Science Teachers’ TPACK should be significantly greater than 15.0 which is the expected average for each of the Science Teachers’ TPACK. This hypothesis was tested with a test of one sample mean (population t-test). The result is presented in table 1

Table 1: Population t -test analysis of the extent of of science teachers’ Technological Pedagogical Content Knowledge

Sub-variables	Observed mean	Mean error	SD	df	t-value	p-value
Knowledge of technology	21.51	0.134	2.71	405	21.131	.000
Pedagogical knowledge	21.79	0.138	2.78	405	27.504	.000
Content knowledge	21.50	0.134	2.70	405	26.098	.000
Pedagogical content Knowledge	21.52	0.129	2.59	405	27.409	.000
Technological content knowledge	21.59	0.130	2.63	405	27.519	.000
Technological pedagogical knowledge	21.47	0.120	2.43	405	28.783	.000
Technological pedagogical Content knowledge	21.89	0.128	2.57	405	30.570	.000

*Significant at the .05 level; t-critical =1.96; N=406; Expected mean=15.00

The information in table 1 also revealed the computation of t-value of teachers’ TPACK, in terms of teachers’ knowledge of technology (t=21.181; p=.000), teachers’ pedagogical knowledge (t=27.504; p=.000), teachers’ content knowledge (t=26.098; p=.000), teachers’ pedagogical content knowledge (t=27.409; p=.000), teachers’ technological content knowledge (t=27.519; p=.000), teachers’ technological pedagogical knowledge (t=28.783; p=.000) and teachers’ technological pedagogical content knowledge (t=30.570; p=.000). They are each higher than the critical t-value of 1.96 (two-tailed test). With this result, the null hypothesis was rejected. Hence, the seven components of science teachers’ TPACK are all significantly high at the 0.05 level of significance.

Ho2: There is no significant influence of gender on teachers’ TPACK in public secondary schools.

The independent variable in this hypothesis is gender while the dependent variable is teachers’ Technological Pedagogical Content Knowledge. In testing this hypothesis, the mean scores of the male teachers’ Technological Pedagogical Content Knowledge for the seven (7) sub-variables of the dependent variables were compared with the mean scores of the female teachers’ TPACK. The results are presented on table 2.

Table 2: Results of independent t - test analysis of influence of gender on science teachers' Technological Pedagogical Content Knowledge

Variables	Group	N	Mean	SD	t-value	p-value
Knowledge of technology	Male	201	21.17	2.67	2.567	.011
	Female	205	21.85	2.58		
	Total	406	21.57	2.71		
Pedagogical knowledge	Male	201	21.12	2.66	5.029	.000
	Female	205	22.40	2.73		
	Total	406	21.79	2.78		
Content knowledge	Male	201	21.21	2.51	2.138	.033
	Female	205	21.79	2.86		
	Total	406	21.50	2.70		
Pedagogical content knowledge	Male	201	21.03	2.41	3.818	.000
	Female	205	22.00	2.67		
	Total	406	21.52	2.58		
Technological content knowledge	Male	201	20.95	2.41	5.030	.000
	Female	205	22.22	2.68		
	Total	406	21.59	2.63		
Technology pedagogical knowledge	Male	201	21.20	2.42	2.138	.033
	Female	205	21.72	2.42		
	Total	406	21.47	2.43		
Technological pedagogical content knowledge	Male	201	21.45	2.57	3.513	.000
	Female	205	22.34	2.50		
	Total	406	21.90	2.57		

*Significant at the .05 level; t-critical =1.96; df =404; N=406

The results presented on table 2 show that male science teachers' TPACK in secondary schools are significantly different from their female teachers' counterparts in term of teachers' knowledge of technology (t=2.567; p=.011), teachers' pedagogical knowledge (t=5.079; p=.000), teachers' content knowledge (t=2.128; p=.033), teachers' pedagogical content knowledge (t=3.818; p=.000), teachers' technological content knowledge (t=5.030; p=.000), teachers' technological pedagogical knowledge (t=2.138; p=.033) and teachers' technological pedagogical content knowledge (t=3.513; p=.000). With this result, the null hypothesis was rejected. Hence, there is a significant influence of teachers' gender on all the seven components of Technological Pedagogical Content Knowledge in public secondary schools at the 0.05 level of significance.

Discussion of the findings

The result of the first hypothesis revealed that the extent of science teachers' Technological Pedagogical Content Knowledge (TPACK) acquisition in public secondary schools is significantly high. The finding is in line with Mai and Hamzah (2016) who examined the primary science teachers' perceptions of technological pedagogical content knowledge (TPACK) addressing teachers' perceptions of the affordances of technology application in instruction, and found that primary science teachers perceive higher self-confidence in pedagogical knowledge in general. The finding agreed with Altuni and Akyildiz (2017) who investigated pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) levels based on different dimensions of TPACK and found teachers to have significantly high and good levels of TPACK. The finding also agreed with Semerci and Aydin (2018) who examined high school teachers' attitudes towards ICT use in education and found that lack of ICT knowledge was the main reason teachers lack confidence in adopting and integrating ICT. Again, the finding is in line with Liu et al. (2015) who in their study surveying Chinese In-Service K12 Teachers' Technology, Pedagogy, and Content Knowledge found a significant difference in TPACK towards teachers. The finding also agreed with Ergen et al. (2018) who used a meta-analysis method to examine whether there is a significant difference in the effect size of the Technological Pedagogical Content Knowledge (TPACK) and found that there is a significant difference between the knowledge types about TPACK. The finding also shows that teachers' TPACK knowledge was significantly high.

The result of the second hypothesis revealed that there is a significant influence of gender on science teachers' Technological Pedagogical Content Knowledge (TPACK) acquisition in public secondary schools. The finding is in line with the finding of Naaz and Khan (2018) who conducted a study to find out the level of Technological Pedagogical Content Knowledge (TPACK) of Pre-service teachers; and found a significant effect of gender on TPACK of teachers. The finding indicates that both male and female teachers differ in Technological Knowledge, but overall TPACK of pre-service teachers have no difference on the basis of gender. The finding disagreed with the finding of Ay et al. (2016), Ersoy et-al. (2016) and Yildiz (2017), who found no significant technological and pedagogical mastery differences between male and female teachers.

Conclusion

Based on the results of this study, it was concluded that, the extent of science teachers' TPACK in public secondary schools is significantly high. There is a significant influence of gender on teachers' TPACK in public secondary schools. This implies that female science teachers show more competencies in technological pedagogical content knowledge than their male counterparts in public secondary schools. However, teachers' technological pedagogical content knowledge are good enough for their investigation into any problem they may have observed in the teaching profession despite some of the factors militating against their successful acquisition of technological pedagogical content knowledge. In conclusion, the teachers' gender is an essential and important factor that should be considered in acquisition of TPACK in order to enhancing effective teaching in secondary schools.

Recommendations

Based on the findings of this study, the following recommendations were made:

- i. Workshops, conferences and seminars should be organised regularly for secondary school teachers to sustain and maintain the high level of technological pedagogical content knowledge they claimed to have achieved.
- ii. Science teachers should be encouraged by relevant authorities to maintain the high level of technological pedagogical content knowledge they claimed to have achieved.
- iii. Since male and female teachers differ in their technological pedagogical content knowledge in public secondary schools, it is recommended that conscious efforts should be made by government and school administrators to improve technological pedagogical content knowledge of teachers irrespective of gender.

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