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Abstract

The study explored the influence of technology on science teachers' PCK and the benefits of that knowledge component on classroom practices. The study relied on science teachers teaching the various science subjects such as Biology, Chemistry, Integrated Science and Physics in Tamale Metropolis, Ghana. Sequential explanatory research design was used, within which was embedded qualitative and quantitative research methods. Fifty science teachers were randomly sampled across three different senior high schools from whom the quantitative data was solicited using questionnaires. Twenty teachers out of the fifty were later purposively sampled from whom the qualitative data was solicited using interview guides and classroom observation checklists. Descriptive statistics was used to analyze the quantitative data and the qualitative data was analyzed through codes and themes. The findings revealed that, effectively integrating technology into the science classroom enhances the easy presentation of instructional content and creates an engaging learning environment. The science teachers' classroom practices such teaching strategies, teaching/learning activities, class management, and students' engagement are improved through effective technology integration. The study therefore recommended that, Senior high schools and their classrooms should be well equipped with the needed technological tools for science teachers to easily and conveniently employ them in teaching.

Introduction

Another important factor principal to educational practice is classroom practice. What goes on within the four corners of a classroom plays a vital role in science instruction, the culture of every class has a great effect on both teachers and learners. Classroom practice is a very significant part of education and affects education in ways that are advantageous, this view is held by Sofianidis and Kallery (2021). What happens in a classroom should be appropriate and rich in experience to enable students develop and grow properly. The proper integration of appropriate technological tools and resources in a classroom, behavior management, right teaching methodologies are a great treasure to the school and society. The reverse of a proper classroom with great practice is detrimental to the student's growth holistically and may pose danger to the society, school and the individuals in the classroom. Technology is a great influencer and its influence on the teachers' PCK and classroom practice cannot be left out. The successes of technology in educational transformation cannot be overlooked. Its impact on educational

resources delivery in recent times has been tremendous in the world. Africa has not been left out and so much is been done in the space of education using technology in the instruction of science.

The height of Covid-19 pandemic in Ghana brought an unpleasant situation in education sector where all schools were shut down and students asked to stay home. There was no hope of returning to the classroom within the shortest possible time making it difficult for teachers and learners to meet physically for normal teaching and learning. This heightened the very need for the utilization of technology and its integration into the instructional process. According to Tuffour et al. (2021), Covid–19 caused an inability of many to fend for vital and necessary materials like school kits, teaching, learning materials (TLMs) and even the safe environment and time to operate. Zoom meetings and google meet platforms were the most resorted by schools.

Many teachers and school authorities were encouraged to utilize technological devices that would limit physical contact in the process of instruction. This experience made stakeholders of education thinking of the possible avenues available by technology for teachers and how they fit in with regards to translating educational experiences to their learners. What science teachers teach, what they teach and to whom and where they teach is crucial in science education. Science teachers PCK a knowledge base that empowers the science teacher to communicate scientific ideas effectively to the understanding of the learners had to be relooked to see how it could be integrated with technology. Due to technological advancement and its influence in other areas of the economy and some units within the educational sector, it has become imperative to apply the scientific know-how in the science classroom.

Simulation-based instructional modules demonstrated efficacy in enhancing the teaching practices of pre-service educators, which resulted in a shift towards more student-centered and interactive pedagogical approaches (Agyei, Jita, & Jita, 2019). The study also added that using technology to simulate lessons in science was an effective way to teach science by teachers and aided students better understanding of what they are taught. Learners find it fascinating learning with technological tools, learning at remote places at one's convenience and motivating learning hence affecting the worth of the instruction and learning process. Li, Liu, and Su (2022), also stated that studies have demonstrated that technology usage is of great benefit for students' learning, aids critical thinking and improves practical and scientific interrogative skills. Technology is an efficient instrument in student learning and in many other fields of life.

According to Ghavifekr and Rosdy (2015), adding and using technology has a potent impact on teachers and learners. The effectiveness of teaching is impacted by technology greatly, the teachers act and art culminates to the teaching process that benefits the learner also. Technology greatly affects the teaching process; the teacher and the classroom environment are not left out from this greater good (Demirel, 2025). Ghavifekr and Rosdy (2015), further states that technology can aid both learners and teachers in their study and professional development and should therefore be explored. A great admonition, that should not be ignored for any reason by science teachers, other subject teachers and the stakeholders of education. This encouraged the utilization of technology by science educators in their instruction and in their self and professional development. Therefore, this study seeks to probe the effects of technology on science teachers' PCK and how that influences their

classroom practices. It focused on determining the benefits of technology integration on the science teachers' instructional content and pedagogy.

Literature Review

Constructivist Theory of Learning

According to Sarbah (2020) constructivist lends knowledge and their ability to make meaning out of the knowledge as a result of their experiences. This is anchored on the ability to accept new information into existing knowledge and reconstructing their understanding to incorporate the new experience. Experiences are important in shaping knowledge and meaning. Previous knowledge of students is important and should not be ignored, it forms the bases on which new information or knowledge is built on. Also, the constructivist theory suggest learning occurs through one's experience and the creation of meaning of what is learnt (Suhendi & ., 2018). The meaning given by the learner to knowledge is as important as the experience of the learner in gaining the knowledge. Amineh and Asl (2015) also state that constructivism intimate's students building and understanding knowledge by interacting meaningfully with their environment and associating previous experience. The environment is important to learners in understanding the world and knowledge presented to them, their relevant experiences is important as well. The physical and psychological environment of the learners has an influence on their learning and the synthesis or construction of meaning of the knowledge they have received or are receiving. The environment provides the platform for experiences to be made for meaningful learning and acquisition of knowledge and the meaning of the knowledge acquired. The environment and experience of students are relevant factors in constructivism as stated by Amineh and Asl (2015); Suhendi, (2018).

Tomljenović and Tatalović Vorkapić (2020) sees constructivism as a learning theory where individuals make and create knowledge according to experiences, they have hard. The revisiting of those experiences helps in making and guiding the knowledge making process. Experiences are at the center of knowledge making and also at the center of the constructivism theory. Suhendi, Purwarno and Chairani (2021) views on constructivism are built on Piaget's cognitive enhancement and Vygotsky's model of sociocultural theory and they intimated that constructivism gives learners the chance to make and create their own knowledge. The knowledge creation or construction is based on their relevant experiences they have made, the reflection and acceptance of the experiences they have used in the knowledge construction. Students' experiences over a period of time forms the building blocks for knowledge construction and making meaning to the knowledge that is beneficial to the needs of their society.

Implications of Constructivism on Classroom Practice

Constructivism presents so many opportunities that can be used or leveraged to cause efficient and improved teaching and learning. According to State budgetary institution of the Kaluga region, " et al.(2021) the implications of constructivism are; The process of knowledge acquisition should be anchored on the environment of the learners. The learning environment should be adapted to suitable conditions in which learners can easily express themselves verbally and non-verbally in ways that will facilitate their learning process, enhance their

concentration and participation in knowledge construction, making meaning of knowledge constructed and it's used to address the challenges in their learning environment and the larger community.

The knowledge acquisition process should not be dependent on only parents and facilitators but also on the experience of learners. Parents and teachers are not absolute fountains and source of knowledge hence they should not be the only ones giving out knowledge and being at the center of learning. It should be a collaboration with the learners who enthusiastically engage in the instructional process, constructing knowledge of experiences drawn from interaction within learners' environment. Mishra (2020), advocates for the change of role of the teacher, in their words they seek for the change of teachers from an all-knowing position to a guide of behavioral change. The teachers should be efficient guides in the knowledge construction process and not lords whose words are final and binding without leaving room for the expression of learners.

Classroom Practice

Byusa, Kampire and Mwesigye (2021), describes classroom practice as all the activities that occur in the learning space when instruction and knowledge acquisition is ongoing. Every activity, strategy, methods that make up the interaction between learners and their teachers to cause and enhance learning and the management of the way students behave in the classroom. They added that classroom practice is a very significant part of education and affects education in ways that are advantageous, this view is held by Sofianidis & Kallery (2021). Sofianidis & Kallery (2021), further stated that the link between the quality and best practices in the classroom are strong. The quality of classroom practices can also be associated with the qualification and knowledge of the teacher.

The classroom is the teachers place of operation and therefore most of the teacher's practices are done in the here for proper and quality socialization. The qualification and knowledge held by the instructor affects the management of the learning space. The experience of the teacher counts too which can influence the PCK of a teacher which may affect classroom practice. Abukari et al. (2022), does mention of the longevity of a teacher in the classroom improves the PCK. The PCK is used in the practice of the teacher, it guides and provides a framework of engagement for the successful practice of the teacher and his influence on the students change and therefore the science teachers' practice is affected greatly by the length of time the science teacher practices. Effective classroom practice cannot be isolated from the pedagogical content knowledge of the teacher. A good PCK influences the effectiveness of the practice of a science teacher in his/her lesson delivery and overall management of the learning space (Gess-Newsome et al., 2019).

Kington et al. (n.d.), identified some important proficiencies regarding classroom practice as follows; organization and management, PCK, PK and Social character. The way a class is organized and managed is so important to the effectiveness of the practices going on in the classroom. The management of time, materials and resources are all important to the effective running of the classroom (Milliken, 2019). Central and significant to the science teachers practice is the exhibition of many ways or art in presenting concepts and principles. Science teachers' use of learning materials effectively enhance and groom their ability to think and keep what they learn (Byusa et al., 2021). They also gave a contrast to effective classroom practices of a teacher as a lack of concentration, a loss of

interest and reduction of outcomes of learning and subsequently the overall performance of the students. A science teachers' social skills in the classroom are an important factor that should not be ignored because of its strong influence on everything and environment of the classroom. The teacher been actively influential in promoting social cohesion of the class is a plus to promoting an effective classroom to enable students' benefit from an effective classroom.

TPACK

TPACK a suitable description of teachers ability and knowledge to include technology in the relevant skill and content knowledge to bring about effective teaching with technological tools (Koehler et al., 2014; Koehler & Mishra, 2009). This scaffolding of PCK is built on Shulman's (1986) work on PCK by synching knowledge of technology, its inclusion or integration into PCK. The framework expands PCK to include knowledge of technology which is important or necessary to guide learning using technology (Koehler, Mishra, & Cain, 2013). Koehler and Mishra (2009.), further noted that the relationship that exist between the three components listed above are equally important, because the activities involved in teaching with technology can be cumbersome and not properly structured. Therefore, one needs an equal knowledge and grasp of all the components of the TPACK to make teaching with technology efficient and effective. TPACK framework suggest the combination and use of scientific know-how in instruction. This requires a good weaving together of every available knowledge of the guide and facilitator of learning (Apau, 2017). Consciously including tools and software in the process of imparting experiences that changes behavior poses a great effectiveness in the instructional process (Ghavifekr & Rosdy, 2015).

According to Mishra & Koehler, (2006) as cited in (Apau, 2017) the complex nature of technology places a daunting task of picking a specific technology to utilize in the process of teaching and acquiring knowledge in every course in every classroom and use by every teacher and learner. This therefore places a responsibility on the users of the technology for teaching to get an understanding of the relationship between the various knowledge sources. Also, the use of the understanding to design specific and appropriate teaching activities using technology for specific lessons has provided better and efficient ways of presenting learning materials. A particular technology or technological tool use in presenting information in a particular unit or subject will not be appropriate to teach another topic in the same subject or better still a particular topic in a different subject. A teachers effective teaching as a result of his ability to connect his knowledge, pedagogy and technology is the goal of TPACK, (Koehler et al., 2014).

Effective instruction while possessing a great knowledge along with comprehension of technological tools, their use in presenting concepts and theories, influencing the teaching processes and activities related to teaching, identifying challenges associated finding better solutions to the challenges and identifying better instructional techniques that make teaching and learning easy (Kapici & Akcay 2023). The influence of technology on the content of teachers they use for teaching should help in presenting difficult theories easily, influencing and motivating learning and improving on the lesson delivery. The technology integrated should make pedagogy of teachers efficient and more effective in meeting their teaching goals and also accelerating and motivating learning

by all categories of students.

Mishra (2019), describes TPACK as the expertise of teachers in inculcating appropriate and needed technology into guiding, facilitating and influencing knowledge and experiences of learners. Argument is made considering contextual knowledge for the TPACK framework. The presence of contextual knowledge will give the framework " semantic consistency" as posited by (Mishra, 2019). this is the integration of the context of the lesson, the subject, the school, the curriculum and national goals. He further argues that for proper integration of technology in instruction knowledge of the context one is operating in must be known to properly and adequately integrate technology into the process of teaching.

Content knowledge (CK) of TPACK

It is difficult to equate the content knowledge of TPACK to content knowledge possessed by an expert in a particular field or subject area (Mishra & Koehler 2009) as cited in (Sensoy & Yildirim 2018). Koehler et al., (2014), refers to content knowledge as knowledge of a particular unit of study or subject matter. The CK of subjects differ with regards to the levels of education involved. The CK of teachers will also differ with varying qualifications and contexts.

Also, Koehler et al. (2014), refers to subject matter expertise of a teacher for teaching a particular subject. The expert knowledge of a teacher to teach or the knowledge base a teacher possesses to enable him/her teach efficiently and effectively. Listiawan et al., (2018) see content technological knowledge as the expertise most sort for by teachers to present subject matter using right tools and programs made available by technology. Presenting content of a subject matter using technology demands a specialized knowledge by the teacher to integrate content and technology effectively. Inadequate understanding of technology will present a difficulty in presenting the information to be presented for effective teaching. It can also present challenges preventing the presentation of content in a manner that facilitate easy teaching.

Kim (2018), refers to content knowledge as the mastery of subject teachers to effectively engage in instruction. A teacher needs to master what he teaches to make knowledge impartation and its receiving process effective and efficient. Costley (2014) described content knowledge as knowing and having cognizance of a unit of study. Knowing what one teaches with great understanding is beneficial. Students may lose interest in learning when the guide for learning has no mastery or does not know what he/she teaches well. When a teacher fumbles and struggle with his content, he causes mistrust for himself and derails the students or learners from the path of understanding. The content knowledge of a teacher is a very special part or domain of the TPACK framework and must be consolidated or made firm to help in the efficient progression of teaching with technology. The CK include the ideas of the skillful instructor on the content and principles underlying the subject matter (Setyowibowo, Sabandi, & Sunarto 2017).

Chan and Yung (2015), describe content knowledge as knowing a what to teach and guiding students to learn. It includes the teacher's strong comprehension which is effective in developing teaching and learning methods with good classroom instructional delivery. Content knowledge affects the content delivery method of the teacher. It

actually improves the pedagogy and self-confidence of the facilitator. It is key that a teacher with excellent pedagogical knowledge who lacks a good content knowledge will struggle in the process of teaching and learning. As much as its importance is mentioned and emphasized the literature here does not extol CK over PK. They are both important domains of PCK which also has a great or good effect on TPACK (Setyowibowo et al., 2017)

Pedagogical Knowledge of TPACK

Melo et al., (2020), refers to PK as the understanding and knowing instructional pathways, knowing methodologies for instruction and the right assessment tools for learning and of learning with appropriate practices that motivates learning. Appropriate practices are contextual and a teacher will have to consider the context he/she finds himself to determine the practices to use in the teaching process. Even methodological choices are not exclusive regarding context. A science teacher with a classroom endowed in quality technological tools and resources that has been integrated properly will use them in ways that are different from a science teacher in another school with less or nothing, this will cause the teachers to use different and appropriate methodologies to help their learners grasp what they are teaching. Same argument can be made for the level a teacher teaches. The technological tools and strategies to use will differ greatly when teaching different grades even by the same teacher. The PK of a teacher have to be contextual to be considered best or optimum to enhance teaching and learning.

Şen (2014), stated that PK connotes the expertise teachers have to efficiently learners to discover knowledge. Pedagogical knowledge encapsulates effective teaching methods, understanding the perceptions students have regarding the plan course of action. The demeanor, behavior and actions of a teacher in the process of teaching can and are indicators that should be looked at to see its influence on teaching and learning since that can in one way or the other affect the perceptions students' hold regarding what is been taught. The perceptions of students include their prejudice or bias towards the subject and their wrong judgement of the instructional process. Knowledge and skill of the strategies and methodologies of teaching helps one change the biases and misjudgment of students to the process of learning and guide their perception to enable them concentrate on worthwhile experiences that is presented to them. The knowledge and skill will also include the skill of manipulating technological tools and including it in classroom activities.

Pedagogical knowledge is the knowledge and abilities, expert teaching capabilities used by teachers for teaching (Apau 2017; Sensoy & Yildirim, 2018). The 'knowledge' used mostly in reference to pedagogy is not the content but rather the expertise, abilities and capabilities of teachers and teaching methodologies or strategies teachers use. Bektas, (2015), suggest physics teachers use materials to show things they are teaching as part of their PK.

The use of models and knowledge of when and how they are applied in the teaching process is an expert knowledge which is not held by many science teachers. This ability is important even in the utilization of scientific tool aids. The advent of technology is making things easier (Batta, 2016), even though sometimes cumbersome will need a good skill and knowledge of it to make the use of its tools as aids in lesson delivery easier for classroom practices. The integration of the knowledge domains of science teachers and its influence on classroom practices is showed in the framework in Figure 1.

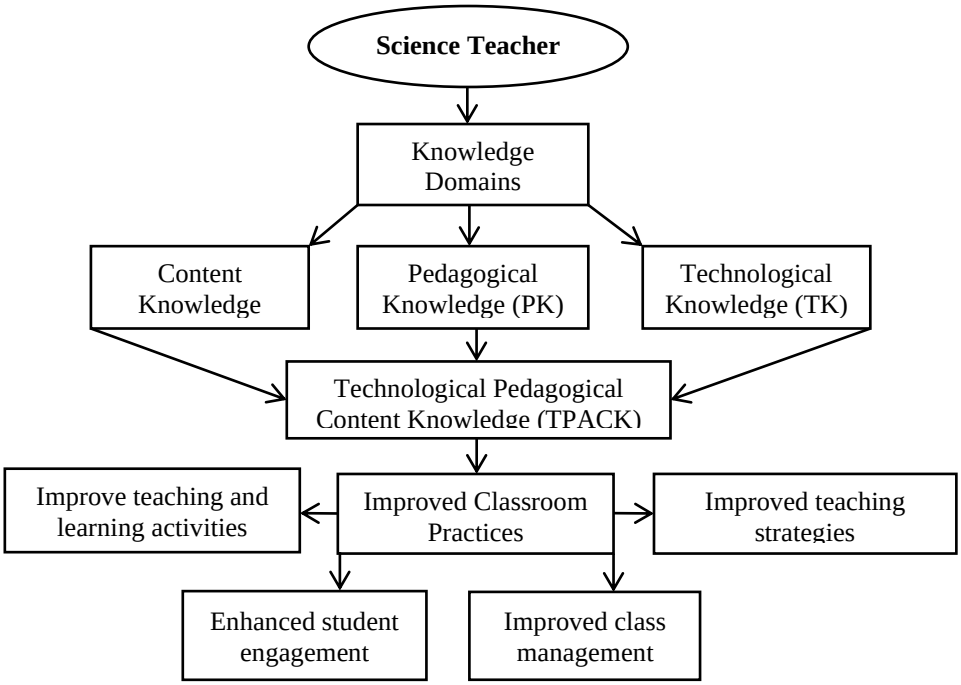

Figure 1. Science Teachers Knowledge and Classroom Practices

Methodology

Research Design

The study applied the mixed method research approach within which the sequential exploratory design was employed. Mixed method is advantageous to researchers because it presents the prospect or opportunity in combining quantitative and qualitative data to attain detailed, thorough, comprehensive with enough information to grasp the problem. Also, Almalki (2016), observed that it is crucial that a meticulous and purposeful sequence of the study is carefully recorded and assessed and that the utilization of mixed methods research coupled with sequential exploratory design can bring to light the likelihood that issues are more multifaceted than initially anticipated, while also affording the chance to establish more convincing and robust social explanations of the social processes under investigation. Toyon (2021), mentions of the stages involved in the sequential explanatory design for gathering data, quantitative data is first collected and analyzed, data is recollected but this time qualitative data is collected. The numerical and qualitative data gathered are married then reported. The sequential explanatory design supported the amalgamation of qualitative and quantitative data sets to allow for results and findings to be logically presented.

Population and Sample

The population for the research included all science teachers (Biology, Chemistry, Physics, and Integrated Science teachers). However, the targeted population was science teachers teaching in High Schools within Tamale Metropolis, Ghana. The research covered three schools within the Metropolis. A sample size of fifty (50) science teachers were selected across the various subjects from the three school. The researchers utilized simple random

sampling approach to select sample participants for the quantitative phase of the data collection and further utilized purposive sampling to select twenty (20) teachers out of the fifty (50) participants for the qualitative data collection phase. The sampling process was organized and orderly and not done in any reckless manner. The chosen subset possessed a representative nature of the broader population, signifying an accurate reflection of the population's overall characteristics.

Research Instruments

The researchers self-constructed three instruments such as four-point Likert scale questionnaire, structured interview guides and classroom observation checklists. These instruments were used to solicit vital information from science teachers on technology integration in teaching science and its influence on their classroom practices.

Data Collection Procedure

The researchers followed research ethical procedures as defined by C. K. Tedam University of Technology and Applied Sciences, Ghana. Permission and approval were sought from management of participating schools to undertake the study using the introductory letter and research ethical letter. The instruments were administered one after the other following the sequential exploratory design. The consent of participants was taken before information was taken from them. No form of data or information was taken without explicitly seeking the consent of the participants.

Data Analysis Procedure

Descriptive statistics such as frequencies, percentages, mean, weighted mean and standard deviations were used to analyze quantitative data that was solicited using four-point Likert scale questionnaire. Themes and codes were employed to interpret the qualitative data obtained from the structured interview guides and the classroom observation checklists.

Results

The study findings revealed the significant impart of educational technology on science teachers' knowledge domains and classroom practices. The demography of the teachers also revealed important findings for science teacher education and training.

Table 1. Demography of the Accessible Population

Demographic Characteristics	Number of Teachers	Percentages (%)
Gender		
Male	36	72
Female	14	28
Educational Qualification		

B.Ed/BSc	27	54
M.Ed/MSc	15	30
MPhil	7	14
PhD Candidate	1	2
Personal Computers (PC)		
Males with functional PC	32	64
Males without functional PC	4	8
Females with functional PC	5	10
Females without functional PC	9	18
Teaching Experience (Years)		
0 – 5 years	17	34
6 – 10 years	22	44
10 and above	11	22
Subject		
Biology	13	26
Chemistry	10	20
Integrated Science	21	42
Physics	6	12

(Source: Field Survey, 2024)

Table 1, which contain the demographic nature of the accessible population revealed that 36 of the teachers representing 72% were males whiles 14 teachers representing 28% of the sample were females. The teachers possessed different academic and professional qualifications which included Bachelor of Education/Bachelor of Science (54%), Master of Education/Master of Science (30%), Master of Philosophy (14%), and Doctor of Philosophy (2%). 64% of male teachers had personal computers that were functional and 8% did not have or either had personal computers that were out of use. Whereas 10% of the female teachers had functional personal computers and 18% did not have or either had non-functional computers. The demography further revealed that the teachers had different years of teaching experiences.

Table 2. Benefits of Technology on the Science Teachers' Instructional Content and Pedagogy

Item	**Frequencies & Percentages**						**Std.**
	SD (%)	**D (%)**	**A (%)**	**SA (%)**	**N**	**X**	**Dev.**
Integrating technology in teaching science enhances the easy presentation of instructional content.	0 (%)	2 (4)	26 (52)	22 (44)	50	3.38	.635
Integrating technology in teaching science lesson creates an engaging learning environment.	0 (0)	2 (4)	24 (48)	24 (48)	50	3.42	.642
Integration of technology helps science teachers update and add new information that are not	0 (0)	3 (6)	17 (34)	30 (60)	50	3.54	.613

Item	Frequencies & Percentages				N	X	Std. Dev.
	SD (%)	D (%)	A (%)	SA (%)			
readily available in books.							
audio-visual lesson help visualize information and concepts.	0 (0)	4 (8)	21 (42)	25 (50)	50	3.40	.700
Technology provides a platform for science teachers to collaborate, share ideas and concepts to provide accurate information to learners.	0 (0)	3 (6)	22 (44)	25 (50)	50	3.44	.611
Integration helps to incorporate different methodologies for teaching.	0 (0)	2 (4)	28 (56)	20 (40)	50	3.34	.626
Technology provides an easy platform to administer and monitor assessment timely.	1 (2)	4 (8)	25 (50)	20 (40)	50	3.22	.864
Integrating technology in teaching help the science teacher adapt to meet the learning needs of all categories of students.	0 (0)	4 (8)	23 (46)	23 (46)	50	3.36	.693
Technology helps to structure activities to make lesson delivery efficient.	0 (0)	2 (4)	20 (40)	28 (56)	50	3.50	.647
Technology opens up lines of communication to help me understand my students.	0 (0)	4 (8)	27 (54)	17 (34)	50	3.30	.614

(Source: Field Survey, 2024). SD: Strongly Disagree, D: Disagree, A: Agree, and SA: Strongly Agree.

Weighted mean (Mean of Means) = 3.39

Table 2 contain results from a four-point Likert scaled items. The items were scaled as 1, 2, 3, and 4. These values represented strongly disagree, disagree, agree and strongly agree respectively. The intervals for the means of the response were determined as 1.00 to 1.75 for those who strongly disagree, greater than 1.75 to 2.50 for those who disagree, greater than 2.50 to 3.25 for those who agree as well as greater than 3.25 to 4.00 for those who strongly agree to the various statements.

Influence of Technology on Classroom Practices

Through structured interview guides and classroom observation checklists, qualitative data was solicited from twenty science teachers across the various science disciplines. The twenty teachers were selected purposively from the fifty teachers that took part in the quantitative phase. The qualitative data was analyzed through the following themes.

Theme 1: Improved Teaching Strategies

The use of technology makes the art of presenting information during lessons interesting. The use of computer devices such as projectors for lesson presentations improved visualization and audio. The learners are able to

create a mental image of what they see and read. Technology integration is a driving force for science teachers improved methods of teaching since its application drastically helped learners to focus on concepts of subject matter presented to them. It improved cooperative learning since learners collaborated in small groups to work on a given task, and this further promoted student-centered approach to learning.

Theme 2: Improve Teaching and Learning Activities

The integration of technology provides an opportunity for science educators to apply differentiated instructions and to easily modify their classroom activities to suit the diverse learners' needs and aspiration. Improvisation and modelling of teaching resources is made easier through the application of educational technologies.

Theme 3: Enhanced Student Engagement

The students participate actively when integration and use of technology during lessons is done by the teacher. It ensured interactive lesson delivery. Learners' cognitive engagement is improved in a great manner which was evident in their abilities to establish realistic connection between academic contents and real-life experiences through technology experiential learning.

Theme 4: Improved Class Management

Finally, the teachers revealed that, they love to use technology so much in their teaching because of the many benefits it presents, but one benefit that excites them is how the use of technological tools makes them facilitators in their classrooms. Classroom management task requirements of a science teacher are lessened through technology integration since learners are enthusiastically engaged with learning tasks.

Discussion

Table 2 indicated that the majority of the science teachers with mean and standard deviation (M=3.54, SD=0.61), agreed strongly that technology helps science teachers update and add new information that are not readily available in books. This is significant in the improvement of the content knowledge of the teacher. Also, a majority of the respondents (M=3.50, SD=0.64), strongly agreed that technology helps to structure activities to make lesson delivery efficient. Science teachers strongly agreed that technology provides a platform for science teachers to collaborate, share ideas and science concepts to provide accurate information for learners (M=3.44, SD=0.61). Also, a majority strongly agreed that integrating and use of technology in teaching science lesson creates an engaging learning environment (M=3.42, SD=0.64). A majority with mean and standard deviation (M=3.40, SD=0.70), strongly agreed that audio-visual lessons help to visualize information and concepts. This is significant in the science teachers practice because it removes the science teachers from the center of teaching and learning, making the teacher a guide. A majority (M=3.38, SD=0.63), strongly agreed to the assertion that the integrating technology in teaching science enhances the easy presentation of instructional content. The respondents agreed strongly integrating and using technology in teaching help the science teacher adapt methods and strategies that

meet the learning needs of all categories of students (M=3.36, SD=0.69). Also, a majority strongly supported the idea that integrating and using technology helps to incorporate different methodologies for teaching (M=3.34, SD=0.62).

Incorporating different methodologies help cater for the deficiencies of other methodologies hence improving instruction. A majority of the respondents strongly agreed that technology opens up lines of communication to help them understand my students (M=4.30, SD=0.61). A majority strongly agreed that technology provides an easy platform to administer and monitor assessment timely (M=4.22, SD=0.86). With a weighted mean of 3.39 the respondents showed that technology is beneficial to the science teachers' instructional content and pedagogy. It further revealed that, effective utilization of technology would ameliorate science teacher classroom practices such as teaching strategies, teaching and learning activities, student engagement, and class management.

These findings resonate with other findings around the globe. According to Budhwar (2017) the integration of technology in science education is the gateway to students' success. This is due to the fact that, it improves access to content, collaboration and engaging. It enables students to expand their minds new and emerging dynamics to learning in a more competitive economy. Technology integration in science education significantly impact science teacher performance and productivity through innovative pedagogical and content exploration. Science teacher professional practices in the classroom are a significant indicator of the effective integration of technology (Hero, 2019).

Yılmaz (2023) revealed that, the efficient integration of technology such as simulations, virtual laboratories, robotics, and AI among others provides more realistic, insightful, exciting, and impactful learning outcomes. This was significantly evident in students' increased engagement, ameliorated comprehension of complex content and self-oriented students. According to Aytekin (2007); (Yilmaz, 2024), amid the challenges that teachers face during technology integration, the benefits are enormous. It is the driving force for innovative and personalized learning by students in the 21st century. Furthermore, (Costley, 2014); Honey Vice President (2001) also revealed that technology integration provides a positive students' expectations and learning outcomes. It is an intellectual adventure that should be tailored to meet the expectations and needs of every learner.

Conclusion

One school of thought defined technology as the application of scientific concepts and understanding for practical purposes, especially in the industries. Within the Education industry, its utilization has evolved and its benefits has been found to be enormous. The integration and usage of technological devices and software in education has been considered as a 21st century skill required by both facilitators and learner for effective instruction of science. It presents a platform for science teachers and learners to collaborate, share ideas on things that work or otherwise. The disadvantages of technological usage within the educational sector cannot be overlooked, however its advantages are numerous such that when effectively integrated into the classroom would yield best learning outcomes. Technology is beneficial to the science teacher as revealed by the study and several other findings globally, but if not planned properly can be disruptive in the classroom.

The science teachers' awareness of available educational technologies and their appropriate integration into the instructional process is a vital requirement for improved content and pedagogy. The replicate effects of the science teachers' technological pedagogical content knowledge are evident in improved classroom practices such as teaching strategies, classroom management, classroom activities, and students' engagement. Integrating technology into science teaching through appropriate tools and programs is the most appropriate mechanism that could be utilized to conceptualize abstract contents into real situations and opportunities.

Recommendations

- Classrooms should be well equipped with the needed tools for science teachers to easily and conveniently employ it in teaching.
- Resource personnel should be employed and incentivized adequately to help science teachers navigate challenges they will encounter using technology in their practice.
- Science teachers should be adequately motivated to integrate and use technology in their daily practice.

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