Relationship Between Technological Pedagogical and Content Knowledge (TPACK) Self-efficacy, 21st Century Instructional Skills and Performance of Science Teachers

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Abstract. This study investigated the TPACK self-efficacy, 21st century instructional skills and performance of Science teachers in the three (3) Divisions of the Province of Bukidnon, Mindanao, Philippines. TPACK self-efficacy and 21st century instructional skills were assessed using adopted questionnaires while teachers' performance was assessed using the Philippine Professional Standards for Teachers (PPST) criteria for which descriptive-correlational research design was used. Three hundred and eighty six (386) Science educators participated in the study, and their responses were examined using descriptive-correlational and causal comparative techniques. Path analysis was used to examine the parsimonious link between the causal models and other variables. Science teachers demonstrated excellent TPACK self-efficacy and 21st century instructional skills, resulting in a very satisfying teaching performance. Science teachers' performance was significantly correlated with technological knowledge (TK) which was also the lone predictor of their performance. The best-fitting model of Science teachers' performance was directly anchored to technological knowledge supported by pedagogical content knowledge, content knowledge, communicative and collaborative skills and innovative and ICT skills. Therefore, teachers must be given opportunities to enhance their Technological Knowledge together with their 21st century instructional skills to improve their performance in the academe.

Keywords: Teachers' performance · TPACK self-efficacy · 21st century instructional skills

1 Introduction

The tasks teachers must complete in the classroom might range from the easy to the complex, but they are all crucial and engaging. They consistently make an effort to attend their assignments so they may fulfill the duties placed on them as part of their commitment to their chosen career path. Each learner has been transformed into a capable and useful

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member of society as a result of the various duties that educators have to perform. These responsibilities of instructors have become more difficult in recent years as a result of the pandemic and the logarithmic progression of technical breakthroughs, which has made it necessary for all educators to be proficient in computers, ICT, cellphones, and the internet. Nowadays, technology continuously alters and influences the way we act and experience the world. Technology has a noticeable impact on practically everything we do, and its influence on learning and education is only expanding. The need to incorporate technology into the educational process is important and ongoing nowadays, especially given how dependent the students of this generation are on technology [1]. Technological Pedagogical and Content Knowledge is a term used to explain how technology is used in the classroom (TPACK).

Today's teachers are expected to integrate technology into their lessons in a positive and successful manner; yet, Chen (2008) discovered in his study that some teachers lack the necessary abilities and competences to apply technology effectively in the learning process. In their study titled Measures of Effective Teaching, Kane and Staiger (2012) found that teachers score lowest on complex teaching abilities such as questioning, discussion strategies, and using technology means to communicate with students about subject. In addition, since the abrupt emergence of COVID-19 at the end of 2019, the performance of teachers in providing the necessary education has been significantly diminished.

COVID-19 has brought devastation throughout the world since its breakout in late December 2019, and education, like any other important industry, has been particularly badly impacted. Students, schools, colleges, and institutions have all suffered significant consequences. According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO, 2020), over 800 million students worldwide have been affected; 1 in 5 students are unable to attend school; 1 in 4 students are unable to attend higher education classes; and 102 countries have ordered nationwide school closures, with 11 implementing localized school closures.

Even before the pandemic, the Philippine government is providing initiatives so that technology integration in the Education department can be of full reality and implementation. Although the vision for ICT integration has not been yet fully articulated, the Philippines EdTech ecosystem benefits from strong central government support for expanding access to basic infrastructure, hardware, and software for teaching and learning for all students, whether in school or in the informal, alternative learning system for out-of-school youth. ICT in education has been supported by the Department of Education's school computerization initiatives from 1996, under a program known as the DepEd Computerization Program (DCP), [5], which was followed by the DepEd Internet Connectivity Project (DICP), which began in 2009.

With all of the available efforts to provide the software and hardware for technology integration, it is sad to note that not all of the teachers are provided with lasting training. As of 2016, the Philippine Statistics Authority reported that 89 percent of primary schools had electric power and 78% had computers, but just 26% had internet access. For the secondary schools, 93 percent had electricity and 83 percent had computers but just 43% had internet access [6]. Recently, another factor that teachers are prompted

with is their ability, capacity and confidence with their skills in the 21st century instruction. Specific teaching approaches that govern classroom engagement are known as instructional practices. These beneficial methods have been discovered through student learning research. Teachers employ instructional practices to bring learners ahead in their learning in a more efficient manner. Teachers' continuous professional development has gained traction in most nations across the world due to the inadequacy of teacher training programs in preparing teachers for the problems inherent in the teaching profession. Teachers have sought other methods to refresh their content knowledge and teaching abilities in order to remain relevant in globalized schools due to the dynamic nature of the school atmosphere, teaching tactics, learners' characteristics, and management style. In many nations across the world, teachers' continuous professional development has gotten more emphasis [7].

However, the details on the specific characteristics of teachers in relation to TPACK, instructional practices and performance have not been examined well during the surge of the pandemic. As of to date, there are yet limited studies tackling the data of Filipino Science teachers' TPACK self-efficacy and instructional practices as being related to their performance. This study therefore sought data and information on Science Teachers' TPACK Self-Efficacy, Instructional practices and Performance which could be used as the underpinning idea for their professional enhancement and on shedding light on what aspects of the teachers' professional requirement may be strengthened.

2 Objectives of the Study

The study generally investigated the Science teachers' TPACK Self-Efficacy, 21st century Instructional Skills and Performance in the three (3) divisions of the Province of Bukidnon, Mindanao, Philippines.

Specifically, it aimed to:

1. describe the level of TPACK self-efficacy that the Science teachers exhibit in terms of:
a. Technological Knowledge (TK);
b. Content Knowledge (CK);
c. Pedagogical Knowledge (PK);
d. Pedagogical Content Knowledge (PCK)
e. Technological Content Knowledge (TCK);
f. Technological Pedagogical Knowledge (TPK); and
g. Technological Pedagogical and Content Knowledge (TPACK);
2. describe the level at which teachers possess the following 21st century instructional skills:
a. critical and creative thinking skills;
b. communicative and collaborative skills; and
c. innovative and ICT skills;
3. determine the teachers performance based on PPST criteria:
(a) content knowledge and pedagogy;
(b) learning environment;
(c) diversity of learners;

(d) curriculum and planning; and
(e) assessment and reporting;
4. find out if there is significant relationship between teachers' performance and TPACK Self-Efficacy and 21st century Instructional skills;
5. identify the variable/s that best predicts science teachers' performance; and
6. formulate a causal model that best fits teachers' performance in relation to TPACK self-efficacy and 21st century Instructional skills.

3 Methodology

This study employed a descriptive-correlational design to examine the relationship between teachers' TPACK self-efficacy and their performance. In a similar fashion, a causal-comparative research design was employed. In this study, the researcher examined the relationship between the values associated with the variables "teachers' TPACK self-efficacy" and "instructional practices." Path analysis was done to determine which model has the strongest correlation with teachers' performance.

The research was carried out at secondary schools in the province of Bukidnon, which is located on the island of Mindanao in the Philippines. The province is divided into three divisions, which are as follows: the Division of Valencia City, the Division of Malaybalay City, and the Division of Bukidnon.

The participants were picked using a total sampling technique. All secondary Science teachers who have earned a Bachelor of Science in Secondary Education with a concentration in Biology, Chemistry, General Science, Physical Science, or Biological Science are included in this group, as are all teachers who have not earned a degree in education but have taken professional education courses for students with baccalaureate degrees in science.

As to the requirements for conducting research using human subjects, the researcher considered the protection and the rights of the research participants as defined by ethical considerations. In recruiting participants, prospects were informed that participation would be voluntary and that they could withdraw from the study any time. Participants' responses as well were kept confidential. They were provided with a written document outlining the purpose of the study, their rights as participants, and confirmation that their information remained anonymous throughout the entire process.

The sampling method that was used in selecting the participants was total population sampling where the target participants were the DepEd secondary Science teachers in three (3) divisions of the Province of Bukidnon.

The instruments that were used in the gathering of data for this study were adapted/adopted from several sources and authors.

The research instrument was composed of three (3) parts. Part I dealt with the teachers' TPACK Self-efficacy adopted from Hosseini & Kamal (2012). Part II was the 21st Century Instructional Practices of Teachers that was adopted from Berja (2016). Part III was on the performance of teachers based on the Philippine Professional Standard for Teachers (PPST) of the Department of Education.

In detail, Part I of the questionnaire was concerned on the teachers' TPACK Self-efficacy. It was adopted from Hosseini & Kamal (2012) composed of 41 items for which a letter of permission was secured from the authors.

Part II of the survey questionnaire dealt with the 21st Century Instructional Skills of teachers. The questionnaire was adopted from Berja (2016) that has 21 items which includes the following indicators: critical and creative thinking skills, communicative and collaborative skills, and innovative and ICT skills. Letter of permission was also secured so that the author of the questionnaire was legally notified of the utilization of the instrument.

Part III of the questionnaire was dealing on the performance of teachers with respect to their TPACK-related skills that are present from the Philippine Professional Standard for Teachers (PPST) of the Department of Education composing of 18 items. Only five (5) domains and some TPACK-related strands were utilized for the purpose of the study: The manner of choosing what domains and strands are included is based on the indicators present on the Classroom Observation Tool of the Department of Education before the pandemic and during the pandemic.

Descriptive statistics such as the mean was used to tabulate the data for presentation and interpretation of the data in terms of PPST ratings (outstanding, very satisfactory, satisfactory, fair, and needs improvement), teachers' TPACK self-efficacy and 21st century instructional skills. Pearson Product-Moment coefficient was used to measure the relationship which quantifies the strength as well as direction of such relationship. It was used to correlate teachers' performance with the teachers' TPACK self-efficacy and 21st century instructional skills. Multiple Linear Regression was used to determine which variables can best predict teachers' performance: teachers' TPACK self-efficacy and 21st century instructional skills. Finally, path analysis was employed to determine the best causal model in order to assess the goodness of fit of the hypothesized models. Optimum causal model for teacher performance was determined by computing the following indices: Chi-square/degree of freedom, Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Normal Fit Index (NFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA).

4 Presentation, Analysis and Interpretation of Data

This presents the interpretation and analysis of data gathered from all public Junior High School and Senior High School teachers in the three (3) divisions of the Province of Bukidnon, Mindanao, Philippines.

4.1 Technological Pedagogical and Content Knowledge (TPACK) Self-efficacy of Secondary Science Teachers

Table 1 displays the summary of the respective knowledge domains of the TPACK Self-efficacy. Accordingly, a grand mean of 4.23 which has a qualitative interpretation of "High self-efficacy" in the overall TPACK Self-efficacy was obtained from the JHS and SHS teachers of the Divisions of Bukidnon, Malaybalay City and Valencia City. Likewise "High level of TPACK Self-Efficacy" was also obtained in all of the seven (7) knowledge domains: TCK has the highest mean score of 4.30; followed by CK (4.27); PK (4.25); TPK (4.23); PCK (4.22); TPACK (4.21); and TK has the lowest mean score of 4.15.The data help us understand that at the present challenges of the overwhelming

pandemic, teachers showed higher level of self-efficacy on TCK suggesting that teachers are more into relating themselves with the necessary technological efficiency coupled with their mastery of the content in their respective fields of expertise.

In the light of the study, it is found out that teachers having high level of self-efficacy in pedagogy are far more confident in integrating technology which refines of their knowledge in the content and pedagogy. Teachers' technological content knowledge is at the heart of effective teaching as far as the study is concerned. Educators must overcome certain traditional professional learning practices if an increase in the quality of teaching and learning core topic areas is desired. Additionally, educators value and expand their perspectives of being specialists by using technology to enhance subject matter teaching skills supported by the foundations of TPACK (Mishra and Koehler, 2006). They are also commited to high-quality professional development aimed at furthering their knowledge. Similar to the result of this study, Ertmer and Ottenbeit-Leftwich (2010) assert that there is a strong cohesiveness of Technology blended with Content Knowledge domain. In Simsek's (2011) study, it was also discovered that maintaining a learning environment that is integrated with technology makes instruction more effective and permanent. According to Celik et al. (2014), however, the process of integrating technology into education creates severe pedagogical issues for instructors and the learning environment. The majority of these issues arise from lack of adequate and suitable pedagogical approaches to teaching using technology [14]. As a result, in order

Table 1. Summary Table of Science teachers' TPACK Self-Efficacy

TPACK Self-Efficacy Indicators	Mean	Descriptive Rating	Qualitative Interpretation
Technological Content Knowledge	4.30	Agree	High level of Knowledge
Content Knowledge	4.27	Agree	High level of Knowledge
Pedagogical Knowledge	4.25	Agree	High level of Knowledge
Technological Pedagogical Knowledge	4.23	Agree	High level of Knowledge
Pedagogical Content Knowledge	4.22	Agree	High level of Knowledge
Technological Pedagogical and Content Knowledge	4.21	Agree	High level of Knowledge
Technological Knowledge	4.15	Agree	High level of Knowledge
OVERALL MEAN	4.23	Agree	High level of Knowledge

Legend:
RangeDescriptive RatingQualitative Interpretation
4.51–5.00Strongly AgreeVery High level of Knowledge
3.51–4.50Agree High level of Knowledge
2.51–3.50Neutral Moderate level of Knowledge
1.51–2.50Disagree Low level of Knowledge
1.00–1.50Strongly DisagreeVery Low level of Knowledge

for teachers to achieve successful technological integration in sync with evolving technology, some competencies such as 21st century skills/abilities have become necessary [15].

4.2 21ST Century Instructional Skills of Science Teachers

Rapid changes in the world are redefining the broad skill sets that teachers need to be adequately prepared to participate in and contribute to today's societal demands, including technological advancement, scientific innovation, increased globalization, shifting workforce demands, and economic competitiveness pressures. The necessity of 21st-century instructional skills in science education is now more important than ever before in order to give learners with the necessary competency in education that they can effectively use in facing the challenges of the real-world.

In Table 2, the overall result of the 21st century instructional skills is presented with a total mean score of 4.12 which is verbally interpreted as 'highly skilled. Since they are the primary criteria of employment credentials among educators, it is claimed that '21st century instructional skills' such as creativity, communication, critical thinking, and cooperation have been the centre of attention and one of the most wanted skills and abilities [16].

Teachers have a far greater impact on students' lives than most people realize. They are instruments capable of igniting strong ideas in pupils and realizing their full potential. Being a 21st-century educator entails being able to teach and reach out to all types of students. That is, delivering the necessary skills that the students need to develop among themselves. In the premise of this study, teachers are significantly practicing the 21st century instructional skills in every subjects that they handled. It follows then that they have already developed such skills and that they are using them to improve the quality of their instruction together with the desire to improve students' progress. Durak (2019)

Table 2. Summary Table of Science teachers' 21st Century Instructional Skills

21st Century Instructional Skills Indicators	Mean	Descriptive Rating	Qualitative Interpretation
Innovative and ICT Skills	4.12	Frequently	Highly Skilled
Communicative and Collaborative Skills	4.12	Frequently	Highly Skilled
Critical and Creative Skills	4.11	Frequently	Highly Skilled
OVERALL MEAN	4.12	Frequently	Highly Skilled

Legend:
RangeDescriptive RatingQualitative Interpretation
4.51–5.00 Very Frequently (VF) Very Highly Skilled
3.51–4.50Frequently (F) Highly Skilled
2.51–3.50Occasionally (O) Moderately Skilled
1.51–2.50Rarely (R) Least Skilled
1.00–1.50Never (N) Not Skilled At All

have come up with similar result in their study asserting that teachers of the modern day do practiced these skills in the classrooms. Unfortunately, P21 (2020) stress out that teachers are having difficulty in practicing communication and collaboration instructional skills in the time of pandemic due to the fact that group work tasks are minimally given to the students.

4.3 Science Teachers' Performance

Teaching is often regarded as one of the most important and demanding professions in modern society. Teachers are held accountable for their learners' academic success as well as their social and emotional growth. Their performance at work, which is linked to students' results, is of critical importance to stakeholders, including administrators, parents, politicians, and society as a whole, given the high demands and expectations in terms of student progress. The assessment of teachers' performance was clustered into 5-point scale such as Outstanding (O), Very Satisfactory (VS), Satisfactory (S), Fair (F), and Needs Improvement (NI).

Table 3 displays the summary of the variables of teachers' performance. The overall mean of teachers' performance on learning environment is 3.78; on diversity of learners 3.78; on assessment and reporting 3.75; on content knowledge and pedagogy 3.75; and curriculum and planning 3.72. The average mean of the teachers' performance is 3.76 which corresponds to "Very Satisfactory".

This study expresses that the JHS and SHS science teachers have a very satisfactory teaching performance. They have been highlighting all of the necessary skills for them to be able to deliver the quality education deserve by Filipino learners in spite of the challenges brought upon by the pandemic. With the performance that teachers have showed in the study, it can basically create an idea that learners will also be able to show a significantly high level of academic performance since teachers are considered

Table 3. Summary table of Science teachers' Performance

Teachers' Performance Indicators	Mean	Qualitative Interpretation
Learning Environment	3.78	Very Satisfactory (VS)
Diversity of Learners	3.78	Very Satisfactory (VS)
Assessment and Reporting	3.75	Very Satisfactory (VS)
Content Knowledge and Pedagogy	3.75	Very Satisfactory (VS)
Curriculum and Planning	3.72	Very Satisfactory (VS)
OVERALL MEAN	3.76	Very Satisfactory (VS)

Legend:
Range Qualitative Interpretation
4.51–5.00 Outstanding (O)
3.51–4.50 Very Satisfactory (VS)
2.51–3.50 Satisfactory (S)
1.51–2.50 Fair (F)
1.00–1.50 Needs Improvement (NI)

as the most important school-related factor that influence students' achievement [19]. By the foundation of the ideas in the Theory of Performance, this study also shows that performance of teachers could really be improved provided that they have the proper support and an environment that is uplifting. Secondary Science teachers in the three divisions can then be able to make use of this realization in securing the respective indicators of their performance to be of prime importance from the crafting of their needs assessments to the implementations of the program they are part of.

4.4 Correlation Between Science Teachers' Performance and TPACK Self-efficacy and 21st Instructional Skills

Table 4 shows the correlation coefficient of teachers' performance to TPACK Self-efficacy and 21st century instructional skills of teachers. The data show a correlation value between teaching performance and technological knowledge (TK) of $r = 0.103$ at $p = 0.043$; pedagogical knowledge (PK) with $r = -0.019$ at $p = 0.712$; content knowledge (CK) with $r = 0.042$ at $p = 0.413$; technological content knowledge with $r = -0.053$ at $p = 0.303$; pedagogical content knowledge (PCK) with $r = -0.065$ at $p = 0.204$; technological pedagogical knowledge with $r = -0.073$ at $p = 0.151$; and lastly, a correlation value of -0.043 at 0.05 level between teaching performance and technological pedagogical and content knowledge (TPACK). Further, the data show a correlation value of 0.049 with $p = 0.338$ between teaching performance and 21st century instructional skills.

The data clearly express a significant relationship between teaching performance and TPACK Self-efficacy under the Technological Knowledge domain. Teachers' optimism in their capacity to use technology tools to deliver and complete the tasks asked of them has been connected to effective teaching performance. Technology can assist enhance teaching and teachers' overall effectiveness by providing access to a wide range of online materials. To supplement traditional teaching methods and keep students more involved, teachers might employ a variety of applications or reliable internet resources.

Teachers may save a lot of time by using virtual lesson plans, grading tools, and online exams, giving them more time to accomplish the job that is needed of them. Furthermore, technology has the potential to improve teacher-student interactions. When teachers successfully integrate technology into their subject areas, they become advisers, content experts, and coaches. Teaching and learning may be made more meaningful and enjoyable with the use of technology. Teachers may use their understanding of digital technology to solve issues creatively, finish projects, obtain internationally relevant information, and achieve objectives. Teachers are also reported to be more efficient with their own assignments, since technology aids facilitate the execution of duties requested of them [9]. In the same position, Hero (2019) also posited that the better teachers integrate technology, the better their performances are. Conversely, the lower those teachers integrate technology in teaching, the lower performance they project. Furthermore, the findings of Claro et al. (2018) showed that integrating technology into teaching had a favorable impact on their teaching performance, as well as increased their efficacy and efficiency. Technology integration has the potential to improve all elements of teaching performance, depending on how it is implemented. Teachers' performance improves as a result of technological developments.

Table 4. Correlation analysis between Science teachers' performance, TPACK Self-efficacy and 21st Instructional Skills

Indicators	CORRELATION COEFFICIENT (r)	PROBABILITY
TPACK Self-Efficacy		
1. Technological Knowledge	0.103	0.043*
2. Pedagogical Knowledge	−0.019	0.712ns
3. Content Knowledge	0.042	0.413 ns
4. Technological Content Knowledge	−0.053	0.303 ns
5. Pedagogical Content Knowledge	−0.065	0.204 ns
6.Technological Pedagogical Knowledge	−0.073	0.151 ns
7. Technological Pedagogical and Content Knowledge	−0.043	0.397 ns
21st Century Instructional Skills	0.049	0.338 ns
1. Critical and Creative Thinking Skills	−0.014	0.783 ns
2. Collaborative and Communicative Skills	0.069	0.176 ns
3. Innovative and ICT Skills	0.053	0.295 ns

* Correlation is significant at the 0.05 level (2-tailed); ns- not significant

4.5 Predictor Variables on Science Teachers' Performance

Table 5 estimated the impact of influence upon the dependent variable. Multiple regression generally allow this study to model, explain and examine the influence of multiple independent or multiple predictor variables to the dependent variable. The extent of influence of the independent variable such as the TPACK Self-efficacy on TK domain on Science teachers' performance is discussed in this section.

Only one predictor variable was found to have influence on teachers' performance. This is the TPACK Self-efficacy on TK domain. It has a beta value of −0.103 at p-value of 0.043 and $r^2 = 0.011$, TK domain of TPACK Self-efficacy have influenced the Science teachers' performance of the three DepEd Divisions of the Province of Bukidnon. Even with a very least value garnered from the study, technological knowledge surely has been found to be of great importance in the present day for the teacher's total performance. Based on the screening procedures for teacher hiring, it has been found out that teachers already have the necessary knowledge in the content and pedagogy by the time they are hired [20] and so technology integration will really be of prime factor to further their performance in the teaching-learning process [8, 21, 22] With the shift on the delivery

Table 5. Extent of Influence of Predictor Variables on Science Teachers' Performance

Predictor Variable	Unstandardized Coefficient Beta	Standard Error	Standardized Coefficient Beta	T-Value	Probability
(Constant)	4.110	0.175	0	23.453	0.000
Technological Knowledge (TK_SE)	0.085	0.042	-0.103	-2.028	0.043
	R = 0.107	$R^2 = 0.011$	F = 4.114		Sig. = 0.043

of instruction, mastery of technology integration is needed to secure the effective provision of quality education. Science teachers' judgments of their skills and competence in technology integration are a reflection of their very satisfactory performance. Such understanding contributes to an individual's conceptualization of his or her educational goals. Their positive perception of their technological integration, on the other hand, inspires confidence and assurance in their teaching abilities.

Lastly, it can be claimed that the regression model is a good fit data since the table shows that one of the sub-variables of the independent variable statistically was a predictor of the dependent variable as illustrated by F = 4.114 at p-value 0.043. The model for Science teachers' performance is illustrated below.

Y = 4.110–0.085 X.

Where:

Y = Science teachers' performance.

X = TPACK Self-efficacy on Technological Knowledge domain.

Balog (2018) described that technological self-efficacy directly affects the teachers' performance and was supported by Pompea and Walker (2017) in their study emphasizing that technological self-efficacy among teachers is an essential predictor of successful implementation of instruction and other duties and responsibilities tasked on them.

4.6 Causal Model Data Fitting

The Parsimonious model is shown in Fig. 1. Five (5) exogenous variables emerged to have a direct link to the Science teachers' performance which emerged best fit. To wit, variables: CK_SE with 0.09, CCS_IS with 0.06, IIS_IS with 0.04, PCK_SE with -0.06, and TK_SE with -0.09. With these five variables link to the Science teachers' performance, CK_SE gives the greater beta value of 0.09 over the other. This relates to the assumption that if an educator has a well-established knowledge and mastery in the content of the subject matter he/she is handling, his/her performance is directly affected.

Table 6 displays the direct and indirect effect of the variables considered in this study. The data reveal five variables which have direct link to the Science teachers' performance: content knowledge, communicative and collaborative skills, innovative and ICT skills, pedagogical content knowledge, and technological knowledge. However

Table 6. Direct and Indirect Effect of the Variables in hypothesized Causal

Variable	Direct Effect	Indirect Effect	Total Effect
TPERFORM ← CK_SE	0.088	0.000	0.088
TPERFORM ← TK_SE	−0.104	0.010	−0.094
TPERFORM ← PCK_SE	−0..077	0.020	−0.056
TPERFORM ← TPK_SE	0.000	0.015	0.015
TPERFORM ← CCS_IS	0.055	0.000	0.055
TPERFORM ← CCT_IS	0.000	0.017	0.017
TPERFORM ← IIS_IS	0.033	0.010	0.044

indirect link to the teachers' performance was also established with that of technological pedagogical knowledge and critical and creative thinking skills.

Table 7 reveals the goodness of fit measure of Science teachers' performance. The data in the table show that all of the values in this model meet the standard values of the goodness of fit for the Science teachers' performance model.

As gleaned in the table, the CMNI/DF of Causal Model 3 is 0.543, which interprets to being considered as the best fit model; a model is considered best fit if the Chi-Square value is near zero but not more than two. In addition, the P-value of Causal Model 3 is 0.802, which satisfies the standard value at >0.05. Furthermore, its CFI which has the standard value of greater than 0.95 is satisfied in this model which is 1.000, in NFI with a standard value of more than 0.95, this model has 0.984, its GFI with a standard value of greater than 0.95, model 3 has 0.998, and TLI standard value is greater than 0.95, causal model 3 has 1.060. As to the RMSEA, a model is considered a good fit if it satisfies the value of less than 0.05, thus, causal model 3 is a good fit since it has a value of 0.000. Therefore, Causal model 3 is considered the causal model that best fits Science teachers' performance.

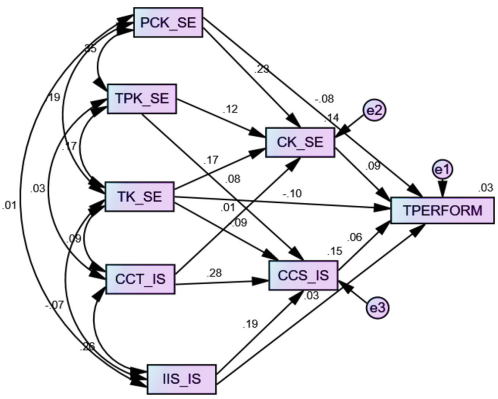

Fig. 1. Parsimonious model on Secondary Science teachers' performance

Table 7. Goodness of Fit Measures of Science Teachers' Performance Model

Standard Index	Standard Value	Causal Model Value
CMIN/DF	<2.00	0.543
P-value	>0.05	0.802
GFI	>0.95	0.998
CFI	>0.95	1.000
NFI	>0.95	0.984
TLI	>0.95	1.060
RMSEA	<0.05	0.000

Legend:
CMIN/DF-Chi-Square/ Degree of Freedom
GFI-Goodness of Fit Index
CFI-Comparative Fit Index
NFI-Normed Fit Index
TLI-Tucker Lewis Index
RMSEA-Root Mean Square of Error Approximation

The finding of this study which showed that content knowledge, communicative and collaborative skills, innovative and ICT skills and technological knowledge were the variables which have direct link to the Science teachers' performance.

The content expertise of teachers has an impact on how they understand the content goals that they are supposed to achieve with their students [25]. It has an impact on how teachers listen to students and respond to their inquiries [26]. It impacts teachers' capacity to explain things effectively and ask appropriate questions, as well as their ability to approach a concept with pupils in a flexible way and establish connections [27]. Further, according to Tschannen-Moran et al. (2008), attainment of a very good teaching performance is related to the teachers' mastery of subject matter. Lastly, according to Agustini et al. (2019), in order to teach all students according to today's standards, teachers must have a deep and flexible understanding of subject matter in order to assist students in creating useful cognitive maps, relating one idea to another, and correcting misconceptions. Teachers must be able to see how concepts relate to one another and to real life. When manifesting these terms, teachers are seen to be more eloquent with their performance linked to the teaching and learning process.

The importance of pedagogical content knowledge (PCK) in classroom instruction cannot be overstated. A PCK in the teaching and learning process refers to a teacher's ability to communicate the subject matter's conceptual approach, relational knowledge, and adaptive reasoning [30]. With the posits in PCK, Science teachers are being 'teachers' rather than being a 'scientist' as they have with them the mindfulness in delivering the content using the proper strategies/pedagogies in the management of learners. Similarly, Akyuz (2018) also had established that teachers are becoming more competent in the teaching-learning process when they have the proficiency in the PCK knowledge domain. Pompea and Walker (2017) asserts that with educators well developed PCK, it directly

provides a positive learning outcomes and elegantly develops critical thinking among learners.

Technology may help improve education by providing access to a wealth of online materials. To supplement traditional teaching methods and keep pupils more involved, teachers might employ a variety of applications or trustworthy internet resources. Teachers may save a lot of time by using virtual lesson planning, grading tools, and online exams. Furthermore, Orlu (2013) asserted that teachers in the current day have a substantially high intelligence in technology, from learning a newly introduced tool through its application and up till looking into how the tool may be used in academe and in real-world situations. These findings also agree with Hatlevik and Hatlevik (2018), who argue that technology teaching self-efficacy is required for a far more successful educational platform, which will lead to exceptional overall teacher performance.

Moreover, according to Jang (2003), teachers with developed 21st century communication instructional skills may quickly awaken the quality of their students, resulting in improved psychological growth. Desirable and achievable goals include teaching students to think critically, collaborate successfully, and communicate clearly. Continuous participation in the lecture enhances discussion productivity and quality, which has a substantial influence on student learning.

Lastly, According to Buabeng-Andoh (2017), there has been a significant increase in teachers' innovativeness and ICT abilities as a response to societal needs and as a result of teachers improving other important teaching skills. However, contrary to the claims made in this study, Nut (2010) claims that teachers' innovativeness decreases as they gain relevant ICT experience due to the ways in which teachers spend more time and effort browsing to already available resources on the internet rather than providing their own authentic tasks and requirements.

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AUTHOR'S Contribution. The following are the contributions of the authors as far as the study is concerned:

It has been found out that the Science teachers possess a High Level of TPACK efficacy; that they are highly skilled in the 21st Century Instructional Skills; and they have very satisfactory teaching performance.

The authors also have found out that for the teachers to perform well in their respective duties and responsibilities during the pandemic, they have to be well equipped with the relevant technological knowledge and skills.

Lastly, content knowledge, communication and collaboration skills, innovative and ICT skills and technological knowledge largely contribute to the performance of teachers.

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