International Journal of Social Science And Human Research

ISSN(print): 2644-0679, ISSN(online): 2644-0695

Volume 05 Issue 03 March 2022

DOI: 10.47191/ijsshr/v5-i3-56, Impact factor- 5.871

Page No: 1143-1153

Exploring Secondary Schools Science Teachers Cognizance on TPACK in Technology Enhanced Learning during the 3rd Wave of Covid-19

Nelson Cyril[1], Khar Thoe Ng[2], Deva Nanthini[3], Sivaranjini Sinniah[4], Sharfuddin Shukor[5]

[1,2,3,4,5] Training and Research Division SEAMEO RECSAM Penang, Malaysia

ABSTRACT: Technology in education has become an important tool for teachers to disseminate or share their knowledge with students. Incorporating Content, Pedagogy and Knowledge (TPACK) skills can benefit teachers and studenrs in increasing their teaching and learning in this classroom. There were many studies done on teachers TPACK and their categorization but very few in the Malaysian context. This study aimed to explore the Malaysian context, in particular the state of Penang of Teachers TPACK on Technology Enhanced Learning (TEL) during the 3rd wave of the Covid-19 pandemic. This study employed a qualitative exploratory research design with sample of five teachers. The results indicated that TPACK on TEL discovered attributes that teachers revealed to enhance their teaching and learning processes and serves as an indicator on the types and use of technology in the classroom. The study could also provide information on teachers' TPACK attributes in improving students grasping of science concepts. In the future these attributes can be extended and compared with pre-service teachers to give a better overview on teachers' TPACK and their use of technology in education.

KEYWORDS: TPACK, Technology, Science Education, Covid-19, Technology Enhanced Learning

INTRODUCTION

Internationally all countries want a scientifically literate population with scientific knowledge and an understanding of the nature of science and scientific inquiry. This is because the world is increasingly becoming a scientific and technological world dominated by consistent developments. One approach in gaining this is through the education sector. Teachers in the education sector need to equip themselves with technological tools to help their students grasping of the content knowledge. Such tools need to be incorporated with pedagogy skills and may be a hindrance to them. This is because teachers themselves need to strike a balance between technological, content and pedagogy skills also called the Technology, Pedagogy and Content Knowledge Skills or TPACK.

One main challenge of teachers' TPACK involved engaging students with lesson materials and consequential lessons more so during the Covid-19 pandemic. The first wave of Covid-19 was experienced from 25 January to 16 February 2020, the second wave from 27 February 2020 to 30 June 2020 and the third wave started from 8 September 2020 (Rampal & Liew, 2021) . Face to face secondary schools sessions were closed from 9th November 2020 to 5th April 2021 during the 3rd wave of Covid-19. On 20th January 2021 school resumed but only online classes were allowed (The Straits Times, 2021). For almost three months into 2021 students had to learn online. By this time most parents were out to work and for many children depending on parents' devices posed much difficulties for online learning.

Despite these challenges, educators continued to hold online classes and develop their online TPACK skills and presence. Educators need to play dual roles when executing online classes i.e., constructors and actors. Constructors in designing tasks, lesson plans and resources while actors when facilitating their online presence.(Rapanta et al., 2020)

BACKGROUND AND RATIONALE

Technology has become embedded in education and the results indicate positive impacts on teaching and learning processes in a classroom (Pierson, 2001). Lessons that are supported by technology will lead to more innovative forms of teaching and learning (Shapley et al., 2011). This is because the use of technology comprise solutions to real-world problems, dissemination of current informational resources, active simulations of concepts, and continuous communication with professionals in the field. Learning to use technology is believed to complement the traditional forms of pedagogical methods (Yasak et al., 2010). Aligned with the use of technology and pedagogy, the purpose of this study is then to explore science teachers' Technological Pedagogical and Content

Knowledge (TPACK) on the use of Technology Enhanced Learning in science education. It is known that the integration of technology in the classroom enhances students' grasping of science concepts worldwide and local.

Generally, teachers are known as the curriculum implementers in a school setting. Therefore, teachers not only have to adapt and well-equipped themselves with pedagogy and content skills but also digital skills in order to integrate the use of technology in a classroom. According to (Neumann et al., 2011), the integration of technology will provide a means to enhance students' learning and engagement in a classroom. Especially, during the Covid-19 pandemic the learning and engagement may be compromised. Thus, this study looks into teachers TPACK skills in using technology enhanced learning tools in their online presence and the attributes it revealed.

Research Questions

1. What are the attributes of teachers TPACK in a science classroom?
2. What are teachers perception of TPACK in the science classroom?

Limitations

Teachers content knowledge for this study is considered equal as the researcher posits that all science teachers are equipped with science knowledge based on their qualifications, a pre-requisite criteria to be a science teacher.

LITERATURE REVIEW

Technology Pedagogical and Content Knowledge term is derived from pedagogy, content, and knowledge (PCK). Assimilating technologies with subject content knowledge and pedagogy or TPACK is thus essential in assisting students' grasping of particularly, science knowledge in schools (Koehler & Mishra, 2009). TPACK was introduced to comprehend teachers' knowledge requiring integration of technology in the classroom. The TPACK framework builds on Shulman's construct of Pedagogical Content Knowledge (PCK) encompassing the integration of technology in the teaching and learning process (Schmidt et al., 2009). In addition. the TPACK framework introduces the relationships between all components of pedagogical, technology and content knowledge. Seven components of TPACK were derived within this framework as displayed in Table 2.1

Table 1. Technological Pedagogical And Content Knowledge Framework

Components	Description
Technological Knowledge (TK)	The knowledge and skills necessary for using technology such as program installations, word processors, spreadsheets, the internet etc. (Mishra and Koehler, 2006)
Content Knowledge (CK)	The knowledge of a teacher about the concepts and theories related to specific subject-matter; for instance, a chemistry teacher should have adequate chemistry knowledge (Mishra and Koehler, 2006)
Pedagogical Knowledge (PK)	The collection of knowledge about general pedagogy such as classroom management, the way students learn and student assessment that is necessary in any class irrespective of specific subject (Mishra and Koehler, 2006; Koehler and Mishra, 2009).
Technological and Content Knowledge (TCK)	The knowledge about the application of technology to teach specific content, such as simulation to teach gases in chemistry or allowing students to figure out the factors affecting chemical reactions via data logging (Mishra and Koehler, 2006).
Technological and Pedagogical Knowledge (TPK)	The knowledge about how technology can be used in teaching; e.g., how smart boards or animations can be used in teaching and learning settings (Koehler and Mishra, 2009).
Pedagogical Content Knowledge (PCK)	The blending of content and pedagogy knowledge. This is related to the application of general pedagogical knowledge within specific content; such as finding the best way to organize the radioactivity concepts in chemistry or applying instructional strategies to teach electrochemistry (Mishra and Koehler, 2006; Koehler and Mishra, 2009
Technological Pedagogical And Content Knowledge (TPCK)	The combination of knowledge of content, technology, and pedagogy, e.g., the use of appropriate technology to assess students' understanding in electrochemistry or detecting students' prior knowledge via simulations for effectively teaching acids and bases in chemistry (Mishra and Koehler, 2006; Koehler and Mishra, 2009).

Koehler and Mishra (2009) developed the TPACK model in 2009 and Mishra (2018) improved on the model by addition of the Contextual knowledge representing constraints experienced by teachers in shaping their TPACK skill in Figure 1.

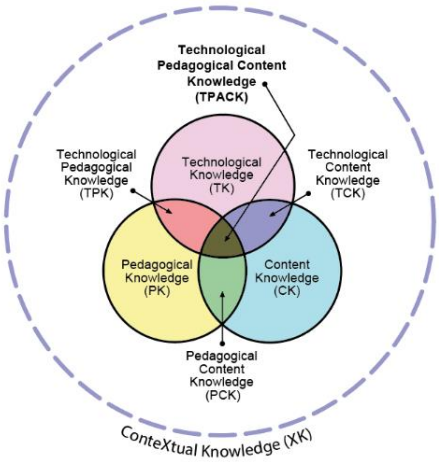

Figure 1. Technological Pedagogical and Content Knowledge model

Such constraints include classroom management, meetings and more. Schmidt et al. (2009), also observed the framework as a measurement of the technological integration level for in-service teachers. Additionally, the framework also give insights to relevant factors that can be included in the training and professional development for in-service and pre-service teachers (Koehler & Mishra, 2005, 2009).

Technology has become embedded in education and the results indicate positive impacts on teaching and learning processes in a classroom (Pierson, 2001). Lessons that are supported by technology will lead to more innovative forms of teaching and learning (Shapley et al., 2011). Other studies supporting the strength of technology have shown the importance of integrating technology and face to face instructions may augment students' engagement in their learning (Cetin-Dindar et al., 2018; Neumann et al., 2011).

- The use of ICT in education sector especially in public schools is inevitable, aligned with the 21st century learning encompassing attitudes, and aspirations in line with global wave of modernization in education (Zainal & Zainuddin, 2020). They elaborated that in Malaysia the use of ICT in education started in 1997 as part of the Multimedia Super Corridor's Flagship Applications with the introduction of smart school project, implemented to develop and equip students with skills to face challenges of the 21st century before entering the workforce. Align with this, the government came to realize of its importance and heavily invested on the 1BestariNet initiative via a learning management system called the Frog Virtual Learning Environment (VLE) that could bridge thousands of primary and secondary schools in Malaysia in a cloud based platform later. Since 1997, the use of technology increased and a study by Ebrahimi (2018) revealed that 76 % of schools in Malaysia use ICT for education, 57% of teachers in Malaysia use ICT for education and 72% of students in Malaysia use ICT for education

The numbers indicated that Malaysian schools have integrated the use of technology in education but their use in schools remains low. Ebrahimi (2018) also uncovered that an average of 2 minutes 46 seconds per hour use of ICT in secondary schools is quite worrying as oppose to an increasing trend use of technologies globally. Therefore, advances in technologies was necessary to meet the increasing trend and coherently increases a higher demand for the use of various technologies in Malaysia's education environment.

However, the advances is more challenging with the presence of Covid-19 pandemic. Covid-19 has changed society's way of life. In an educational institution where the norm mode of teaching is via face to face, the pandemic impacted classroom teaching and learning process. Creating a lesson online formed many difficulties especially for teachers who are not well versed with the use of technology (Wyres & Taylor, 2020).

In light of these challenges many Malaysian educators naturally needed to adapt to technologies to create an online content. Many students from the first wave of covid-19 were unable to continue their education online. Hence, teachers had to device many approaches to capture majority of the students attending their classes (Yates et al., 2020). Generally, online teaching involves a plethora of tools that educators can use in their online classes. These tools or Technology Enhanced Learning (TEL) helped to narrow the gap between the educator and the students where the students is at a distance from the educators (Rapanta et al., 2020).

TEL is a term used describing the amalgamation of digital technology and teaching within an educational setting. TEL is also about educators constantly renewing ways to improve method of delivering content to students (Goodchild & Speed, 2018). The authors go on to say that TEL should be viewed as a social force constructed within a pedagogy realm. Such social force may pose difficulties in an online class especially with educators lack of technology skills in operating an online class.

The conceptual framework for this study is presented below in Figure 2.2.

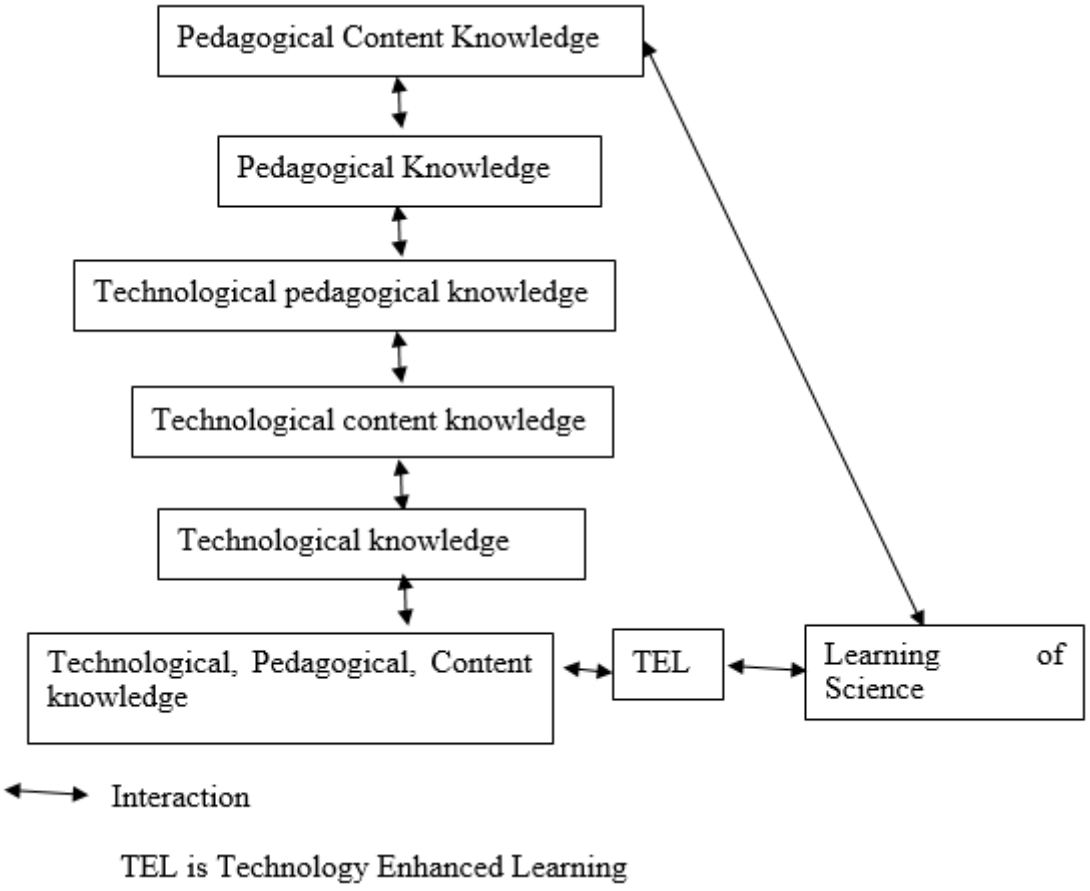

Figure 2. Conceptual Framework for the study on TPACK and AR

Figure 2 displayed the conceptual framework for this study looking into the interactions with teachers' pedagogical content knowledge, pedagogical knowledge, technological pedagogical knowledge, technological content knowledge, content knowledge, and technological knowledge. These 6 individual knowledge will blend and form one entity called TPACK and with the inclusion of TEL may assist in students learning of science. The learning of science also depends on the components of TPACK forming a cyclic process. The success in the learning of science using TEL will depend on teachers TPACK level. Learning to use technology is believed to complement the traditional forms of pedagogical methods (Yasak et al., 2010). It is known that the integration of technology in the classroom enhances students' grasping of science concepts worldwide and local. The level of teachers' level of technology may pose some difficulties especially when we categorize teachers' with levels of TPACK and factors related to it. A review by Malik et al., (2019) identified knowledge of technology alone does not reveal effective technology integration in learning. Malik et al., argued that the content and pedagogy skills are also important in ensuring a successful teaching and learning session. In contrast, another study by Young (2012) characterized pre-service teachers have a stable foundation and were able to integrate knowledge and skills with technology. Educators were seen to reveal certain traits or attributes when running online classes. Thus, this study then focuses on teachers' TPACK in Technology Enhanced Leaning specifically investigating teachers attributes when using technology in the classroom.

METHODOLOGY

a. Research Design

A research design is aimed to research problems in answering research questions. For this study a qualitative exploratory research design is undertaken as an approach for exploration (Creswell & Creswell, 2018). This choice of exploratory approach was made because the study seeks to investigate characteristics of science teachers TPACK on TEL.

b. Sampling

For this study, a purposive sampling procedure is adhered. According to Cohen (2018) for a qualititaive research purposive sampling will ensure the quality of the research. Thus, five science teachers from the state of Penang, Malaysia were selected. A few of the interview questions were modified and adapted from literature and others were constructed by the researcher.

The interviews were performed via phone and prior to that an Informed Consent Letter was given with a brief explanation on the research topics and confidentiality of data. The interviews were conducted from 25th of January 2021 to end of February 2021.

c. Data analysis

For analysis, transcripts were converted into a table format and initial es for coding was performed by examining their respons indications of their understanding of the selected acid-base chemistry concepts. For the purpose of analysing, the researcher used the La) Pelle2004) method of qualitative data analysis. In this method La Pelle used the Microsoft Word Table as a software tool in order to analyse qualitative data gathered from interviews with students and teachers. In the first phase, the gathered participants' responses were formatted into a layout The second phase involved the development of the .e inpresented as an examplcodebook A codebook is a Microsoft Word table format that contained three levels of themes, and their respective numbers created by the researcher.

Table 2. Analysis codebook

Level 1	Level 2	Level 3	Themes
2.000			Topics learn
	2.050		Acids and bases
		2.055	How to test for acids and bases?

For example, in level 1, the code 2.000 is assigned for 'topics learnt '. In level 2 'acids and bases is assigned the code 2.050 while 'How to test for acids and bases ' is assigned the code 2.055.

In the third phase, the participants' responses were assigned with number codes obtained from the codebook. The process of assigning the numbers is called the coding process.

Table 3. Data table for transcribed interviews with assigned numerical

Participant Name	Theme Code	Researcher Question/Participant Response	Sequence#
Researcher	1.000	Q1. What apps do you use?	1
T3	3.60	Holoviewer	2
T3	3.65	Pear deck	3

Table 3uttered by T was "Holoviewer" shows that the phrase 3and assigned the "holoviewer" because the response 3.060 code was identical 'holoviewer' with the theme in the codebook

This process is repeated for all In ad .interviews 5 responses fromdition, the # st shown in the la (sequence ,.e.i)column of Table shows the order of utterances as theinterview progressed according to questions and responses. The coding sequences provide a systematics response f'way to identify each participantor reference purposes.

Ideally, coding and recoding are necessary to ensure consistency and coverage of codes and data (Cohen, Manion, & Morrison, 2011). This step enabled retrieval and categorization to be consistent. Emergent themes were continuously compared for similarities and differences, which led to themes that emerged naturally from the data (Marshall & Rossman, 2011). In addition, the researcher constantly checked the data to ensure it fitted the conceptual framework.

RESEARCH FINDINGS

This study entailed science teachers TPACK in the use of technology enhanced learning (TEL)

The emergent themes arising from this research are explained based on the components of TPACK in Table 2.1.

Technological Knowledge

Creator.

This attributes looks into teachers who create applications based on their knowledge. As an example T3 stated that he is able to use Augmented Reality (AR) markers during his teaching and learning in a face to face session with the following statement.

> *What I create is an Augmented Reality (AR) marker. When we scan the marker on the object, images, moving objects, will appear. All my AR apps has markers.*

Similarly, T2 used hologram to attract students in his science lessons during the Covid-19 MCO. He was only able to introduce the applications to his students and could not fully utilized the apps functionalities. He remarked the statement below as evidence.

I use the topic on animals for students Year 1,2, and 3. I created this hologram to attract them to lessons. Unfortunately, during the MCO its quite difficult.

User.

This 'User' attribute displayed teachers as users of technology such as AR apps. They acquired their use of apps from a third party or development programmes. For example, T4 learned his AR apps from his kids and decided to be a user. He exemplified the *user* attribute when he stated:

I have found AR in my kid's Form 1 science text book because his teacher told him to see it. So I installed the app and use it quite frequent.

Trivial User.

The 'trivial' attribute are not too keen in using the technology. This is because they are not inclined towards technology and believed technology is something difficult. However, during the pandemic this category of teachers used to taking pictures in their lesson and posting it in their whatsapp application as they are used to it.

T1 showed this trait when she stated:

I am not so keen using advance technology . I am used to using whatsapp and telegram. I take pictures and post it on whatsapp

The attribute *'trivial user'* is also shown by T4 when he indicated:

Various ways to make questions through FB. I use telegram to send messages, and pictures because it does not download using the phone memory. The pictures are kept on the cloud In whatsapp if there are too many pictures they will start to delete. With telegram its permanently kept on the cloud

Pedagogical Knowledge

Constructivist.

The use of Inquiry Based Science Education or the constructivist approach attribute was prominent in teachers. However, during the Covid-19 times they were unable to execute such learning.

T4 commented he used IBSE regularly and for the topic of Space and Constellation, he will ask them to do a search and share their findings in an online class. He commented:

"Certain topics like space and constellations I use inquiry based science learning. Usually they just read from the book but I asked them to go and construct their ideas for the meaning of constellations and then we share".

T3 also displayed this attribute when he said

"I asked students to search for a particular science concept on their own especially when their internet is very slow to present slides or videos. Then in the next class we share the findings".

Collaborative.

The social feature of the collaborative attribute was revealed when students were asked to study with their friends and present their findings. T2 was seen displaying this attribute when he stated:

I use a self directed method for the first topic which is Introduction to science or Introduction and rules of the science labs since it is repeatedly discussed every year. Students were asked to collaboratively find information with their partners and share them in the next class.

Similarly T5 shared the same attribute as T4 when he stated:

" I will ask students to communicate with their partner and in the next lesson try to share their findings"

Mix and Match.

The teachers with the *mix and match* attribute usually delivers their content in one way and less of interaction. This lecture method seemed to work for them and they are heavily attached to this method. T5 seemed to demonstrate this attribute when he said.

I wouldnt describe myself using any of those methods (collaborative, constructivism) because I feel like is too rigid. My style is like mix and match looking at the content and students' capabilities.

Technological Content Knowledge

Feature based.

This attribute looked into new applications integrated into the teaching and learning of science. The video and writing features of the applications seemed to engage students. T4 displayed this attribute when he mentioned:

> "*I use Tik Tok in teaching science particularly science topics with easy understanding. Tik Tok features like video and filters are popular with students".*

T3 seemed to be using this attribute too when he used the app 'pear deck' app. He remarked

> *" I use pear deck in zoom where there is a feature in the app that enables students to write their answers for certain science topics in real time".*

Slides.

The '*slide*' attribute is defined as teachers who mostly used the powerpoint presentation. These teachers are used to using powerpoint in their presentation and felt that it was not necessary to use other apps.

T5 commented his preference in his statement:

> *I will show them how to write a science report in the slide. These slides must consist of the scientific principles involved .*

Indicatively, T1 used the powerpoint occasionaly in his class when he stated:

> *"Sometimes I use powerpoint slides too"*

Videos.

A few of the teachers adopted using the 'videos' attribute. This particular attribute uses courseware purchased by school in their presentation. However, during this pandemic they were unable to use it and instead opted to use youtube videos. T4 showed this attribute when he stated:

> *So I use videos on youtube and share them with my students but they don't quite like it if the video is more than 5 minutes. When I share the video they would not watch it and I could not discuss it in class.So if there are two or three short videos on the same topic I would search for the shortest and effective one*.

The attribute *'Videos'* was also seen in T1 remarks:

> *Basically in experiments and then I will show them you tube videos For better understanding*

Technological Pedagogical Knowledge

Gamification.

Gamification is another approach used by teachers to attract students interest in the science subject.

For example, during the pandemic, T2 used games-type lesson in his teaching and learning. He stated that:

> *I use kahoot game. Also, I made quizzes using google form during the mco (Movement control order) which I get from telegram groups*

Evaluation Applications.

Teachers with the '*evaluation application*' used the google form feature the most in this pandemic because the content for the forms were readily available and he was able to obtain prompt results. In addition T1 showed similarity with T4 when he used google form to know their results instantaneously

He depicted this clearly when he stated:

> *During covid I used google form and instantly we can know the results.Many teachers share their google form. So I was able to use them…T4*
>
> *I use google form and provide a link in the whatsapp. The activity will let me know the results quickly…T1.*

Conventional.

The attribute '*conventional*' observed teachers who are used to using whiteboard. These teachers will show a video of them in an application without using the app such as the Whiteboard feature in the room. The teacher cast a physical whiteboard in their homes for teaching and learning. T1 seemed to show this attribute and typified this in his response:

> *Well I don't show myself in zoom but I just showed the whiteboard behind me*

T5 agreed with T1 and showed the '*conventional*' attribute

I am used to whiteboard in school. I have one (whiteboard) at home that I used to teach.

Pedagogical Content Knowledge

Creative.

T1 used same setup like the TV show 'Family Feud' to create excitement in her face to face teaching but had to device new approaches during the Covid-19 pandemic.

The use of this attribute was shown by T1 when he commented:

I use quiz. Something like in the TV where they use the buzzers to answers. There are two groups and I will ask one rep from each group to stand in front the class who are also another rep in a different group. So I will ask a question and the first person who answered correctly wins. If he or she cannot answer then he asked another rep from the same to answer. The children would be so excited.

Additionally, T5 too displayed the "*creative"* attribute when he commented:

Basically taking two paper cups and painting them black. Remove the bottom and replacing it with tracing paper. The other cup prick it with a pin so I taught them the basic to build a pinhole camera in a video. So I guide them during Covid-19 to do this activity at home using whatsapp or others tools.. This is one lesson where students can be creative even during the pandemic.

Transformative.

The *transformative* attribute were observed with teachers who designed a learning session from selected topics in science. For example, T2 exhibited this attribute when he transformed the science concept of density into a water rocket activity.

Yes I used project based learning. In Year 5 pupils are exposed to water rocket from their science concept of density. So in my lesson I transformed the techniques of making a water rocket in videos how I did this

Another teacher, T1 appeared to use this attribute when he affirmed:

Yes the other day I asked students to make compost. We shared on disposable items. I showed them how to put one layer of waste and one layer of soil to make compost. This way the disposables can be transformed to something useful by sharing pictures on whatsapp.

Integrative.

The 'integrative' characteristic featured teachers used to activities during school and continued this method in their online class. For example T1 integrated a song when teaching. He stated this trait:

Yes. My students will collaboratively sing a song on photosynthesis and we tried this online too.

Similarly, T5 signified the use of the 'integrative' attribute when he remarked:

I use youtube in face to face class but now during Conditional Movement Control Order (CMCO) I share the penjerukan (pickling) video that I made via telegram. I will ask students individually with their parents to do pickling and share their video with the class.

Technological Pedagogical Content Knowledge

Motivational.

The teachers using this attribute demonstrated teaching online using apps that he developed. T3 aspired his students and motivated them to study science with the jomsains or 'lets go apps' at each schooling level.

I use games in the form of quizzes. So during Movement Control Order (MCO) I asked students to answer quiz using jomsains app for the topic of animals. For example in the app there is a picture of a tiger. Question asked may be "What does this animal eat". "What is the food habits of the animal in the picture above"?

I sort the questions according to students level of study and to motivate them.

Appropriate.

The teachers using the *'appropriate'* attribute seemed to choose the proper technology for their teaching and learning. For example, T1

Yes. For example for the pickled fruits hands on activities which is a project based learning I used youtube videos to teach Food Preservation which is pickling (penjerukan) I find it very appropriate to use youtube for this home activity.

T2 seemed to have comparable attribute with T1 when he stated:

Yes. For example for the pickled fruits hands on activities which is a project based learning. I used youtube videos to teach Food Preservation which is pickling (penjerukan). I think youtube is best for activity like this.

Acceptable.

The '*acceptable'* attribute depicted teachers very occasionally using technology. Most of these group of teachers use whatsapp or telegram because they are very familiar using these two apps. T4 showed this attribute when he remarked:

I use telegram to send messages, and pictures because it does not download using the phone memory. I will ask students to do work in pairs or group and get back to me in the next lesson.

The acceptable attribute was also revealed when T1 commented:

Because these activities I do it in class not online. For the students to be able to access the online material in class is limited. So I resort to capturing picture and pasting it whatsapp. Also, I mark my papers using whatsapp.

As a note, when the researcher analysed the transcribed interviews it was found that the teachers were able to convey their CK or content knowledge well. Thus, for this study the researcher adopted the notion that all teachers are equally proficient based on their academic qualifications suitable for teaching science.

DISCUSSION

From the findings, results indicated that there are certain attributes of teachers' TPACK on TEL for science teachers. Taken together, there are 21 attributes of teachers from this study. These attributes ranges from types of technology that teachers used to their pedagogical skills. This study agrees with the review by Malik et al (2019) that technology alone could not translate to teachers effective use of the technology. Teachers need to equip themselves with exemplary attributes as above to ensure an integration of pedagogy, content, and technology skills.

This study is then differed with other studies in that teachers' TPACK could be categorized into 21 attributes compared to the study by lee and Tsai (2010). The 2010 study categorized TPCK-W or TPACK-Website into six categories i.e., (a) Web-general (i.e. web-related tools), (b) Web-communicative, (c) Web-pedagogical knowledge (WPK), (d) Web-content knowledge (WCK), (e) Web-pedagogical-content knowledge (WPCK), and 6) attitudes toward web-based instruction. These categories are limited to only websites but this study observed that Penang teachers using applications is more popular with their students.

Based on the data that there are teachers with over 20 years of teaching experiences and many would argue that the these group of teachers occasionally used technology based on their years of experience teaching may impacted their use of technology. However, a study by Jwaifell (2019) observed that Jordanese teachers with more than 10 years experience in teaching did not result in a significant difference in their readiness to integrate technology. The 2019 study evidenced that teachers TPACK has no correlation with number of teaching experiences. Similarly, there are teachers who are over 15 years of teaching were found to explore applications in their online class then teachers with less than five years of service.

IMPLICATIONS

The attributes of TPACK in TEL will enable science teachers to know where they fit and would pose as a brief guidelines of their future planning for a better TPACK skills in the teaching of science in the classroom. The TPACK in TEL attributes that teachers have will enhance teachers teaching and learning in the classroom. Many teachers may try to improve their use of learning applications from the *creator* and *users* attributes seemingly using advance technology such as Augmented Reality technology.

This study could also be expanded to pre-service science teachers. The universities and teachers' training institute will be able to qualitatively measure teachers' TPACK in TEL based on their TPACK component skills and modifying the curriculum to improve teachers TPACK in TEL.

CONCLUSION

The categories and attributes of science teachers TPACK plays an important qualitative measurement of teachers TPACK in TEL. The teachers acquiring good TPACK skills in TEL are known to improve teaching and learning. The transformation of teachers face to face classes to online classes has forced teachers to learn new things and equip themselves with skills that were alien to them before. Many of these teachers have used many ways and this paper serve as a point of reference for teachers as to what attributes of teachers that were revealed during these online classes as well as the many applications they used.

ACKNOWLEDGEMENTS

The researcher would like to acknowledge all teachers that participated in this study. In addition we would like to express our gratitude to SEAMEO RECSAM for the funding of this study.

REFERENCES

1) Cetin-Dindar, A., Boz, Y., Sonmez, D. Y., & Celep, N. D. (2018). Development of pre-service chemistry teachers' technological pedagogical content knowledge. *Chemistry Education Research and Practice*, *19*(1), 167–183. https://doi.org/10.1039/C7RP00175D
2) Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in Education* (8th ed.). Routledge.
3) Creswell, J. W., & Creswell, D. J. (2018). *Research Design* (5th ed.). Sage.
4) Ebrahimi, S., & Jiar, Y. K. (2018). The use of technology at Malaysian public high schools. *Journal of Education and Review*, *6*(3), 54–60.
5) Goodchild, T., & Speed, E. (2018). Technology enhanced learning as transformative innovation: a note on the enduring myth of TEL. *Teaching in Higher Education*.
6) Jwaifell, M. (2019). In-Service Science Teachers' Readiness of Integrating Augmented Reality. *Journal of Curriculum and Teaching*, *8*(2), 43–53.
7) Koehler, M. J., & Mishra, P. (2005). What Happens When Teachers Design Educational Technology? The Development of Technological Pedagogical Content Knowledge. *Journal of Educational Computing Research*, *32*(2), 131–152. https://doi.org/10.2190/0EW7-01WB-BKHL-QDYV
8) Koehler, M. J., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70.
9) Lee, M.-H., & Tsai, C.-C. (2010). Exploring teachers' perceived self efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web. *Instructional Science*, *38*(1), 1–21. https://doi.org/10.1007/s11251-008-9075-4
10) Malik, S., Rohendi, D., & Widiaty, I. (2019). *Technological pedagogical content knowledge (TPACK) with information and communication technology (ICT) integration: A literature review*. 498–503.
11) Mishra, P. (2018). *Revised version of TPACK image. Retrieved from https://punyamishra.com/2018/09/10/the-tpack-diagram-gets-an-upgrade/*.
12) Neumann, D. L., Neumann, M. M., & Hood, M. (2011). Evaluating computer-based simulations, multimedia and animations that help integrate blended learning with lectures in first year statistics. *Australasian Journal of Educational Technology*, *27*(2), Article 2. https://doi.org/10.14742/ajet.970
13) Pierson, M. E. (2001). Technology integration practice as a function of pedagogical expertise. *Journal of Research on Computing in Education*, *33*(4), 413–430. https://doi.org/10.1080/08886504.2001.10782325
14) Rampal L, Liew B.S. (2021) Malaysia's third COVID-19 wave - a paradigm shift required. *Medical Journal of Malaysia*. 76(1):1-4.
15) Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online University Teaching During and After the Covid-19 Crisis: Refocusing Teacher Presence and Learning Activity. *Postdigital Science and Education*, *2*(3), 923–945. https://doi.org/10.1007/s42438-020-00155-y
16) Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, *42*(2), 123–149.
17) Shapley, K., Sheehan, D., Maloney, C., & Caranikas-Walker, F. (2011). Effects of Technology Immersion on Middle School Students' Learning Opportunities and Achievement. *The Journal of Educational Research*, *104*(5), 299–315. https://doi.org/10.1080/00220671003767615
18) The Straits Times. (2021, April 5). *All 5m students in Malaysia back to school for first time since Covid-19 outbreak.* https://www.straitstimes.com/asia/se-asia/all-students-in-malaysia-back-to-school-for-first-time-since-covid-19-outbreak
19) Wyres, M., & Taylor, N. (2020). *Covid-19: using simulation and technology-enhanced learning to negotiate and adapt to the ongoing challenges in UK healthcare education*. BMJ Specialist Journals.
20) Yasak, Z., Yamhari, S., & Esa, A. (2010). Penggunaan teknologi dalam mengajar sains di sekolah rendah. *Seminar Majlis Dekan Pendidikan IPTA 2010*, 1–7. http://eprints.uthm.edu.my/id/eprint/445/
21) Yates, A., Starkey, L., Egerton, B., & Flueggen, F. (2020). High school students' experience of online learning during Covid-19: the influence of technology and pedagogy. *Technology, Pedagogy and Education*, 1–15.

22) Zainal, A. Z., & Zainuddin, S. Z. (2020). Technology adoption in Malaysian schools: An analysis of national ICT in education policy initiatives. *Digital Education Review*, *0*(37), 172–194. https://doi.org/10.1344/der.2020.37.172-194