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A Physics Teachers' Technological Pedagogical Content Knowledge and Problems in the Instructional Management under the Secondary Educational Service Area Office Sukhothai in the Situation of Coronavirus Pandemic

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Abstract. The COVID-19 pandemic has changed education to integrate more technology in classroom. Technological Pedagogical Content Knowledge (TPACK) is an essential framework that teachers need to know in order to teach with technology effectively. This study examined the TPACK and problems in the instructional management during the COVID-19 pandemic held by 16 physics in-service teachers who teach at schools under the secondary educational service area office Sukhothai. Data sources consisted of questionnaires from 16 teachers and semi-structured interview with 5 teachers. Content analysis was used in data analysis and peer debriefing was used for ensure the trustworthiness in this study. This result revealed that these in-service physics teachers do not have appropriate technological pedagogical content knowledge. They have content knowledge, pedagogical knowledge, pedagogical content knowledge and technological knowledge at good level but, they have technological content knowledge, technological pedagogical knowledge and technological pedagogical content knowledge at low level. In addition, while the COVID-19 pandemic, most schools offered online teaching. Most physics teachers have incomplete level of technological pedagogical content knowledge. The problems that the teachers identified that they encountered in their teaching are 1) In terms of learning management, teachers are unable to manage teaching and learning that emphasizes students' inquiry because the students could not do the experiment or do activities that focus on inquiry, thus the teaching focus solely on Lecture 2) Teachers are unable to integrate the technology in their teaching. and 3) Students are not ready for online teaching, due to lack of learning equipments including computers, telephones and internet.

Keywords: Technological Pedagogical Content Knowledge, Problems in the Physics Instructional Management, COVID-19 Pandemic

1. Introduction

Back to 2019, the coronavirus pandemic changed the education system around the world. Teaching and learning were completely changed. Thailand is one of the country that has most affected. That effect to schools across the country are unable to organize teaching and learning as usual. During the coronavirus pandemic, most of school are using online teaching. when the covid-19 situation has softened, cause people including students and educators are vaccinated. The Ministry of Education has considered allowing schools can open normally (Onsite). If students or educators had infected, the school will consider an appropriate teaching and learning style, that creating a hybrid learning approach. Hybrid learning approach is the appropriately face-to-face and online learning, emphasizing a variety of teaching methods to enable learning interactions between teachers and students through tools, software, and information technology to integrate with teaching and learning to increase efficiency in learning management.

Research findings have shown that technology has a great influence in changing the way of teaching and learning science. Especially in physics subject that are important in science learning because physics is a fundamental content that leads to understand of other fields of science. It is a theme that can be linking the daily events, thereby promoting the understanding of more complex concepts. (Matthews, 1997; Sadler and Tai, 2001; Pruekpramool and Sangpradit, 2016). Moreover, the physics content is quite abstract because the nature of the subject talks about all natural phenomena. Including the knowledge of physics is also obtained from the imagination by creating an idea model using the principles of physics which leads to a theory conclusion and experiments to verify that theory. Therefore, learning physics is difficult to make students understand the concept. Then, integration of technology is essential for physics teaching and learning management. Several relevant research studies indicate the effective of technology in enhancing learning. It helps students come up with ideas. It helps to understand abstract things. It helps to engage and create a positive attitude towards the subject. It is increasing interaction between teachers and students and between students and students. (Cunningham & Carlsen, 2014; Goldfarb, Pregibon, Shrem, & Zyko, 2011; Savasci & Berlin, 2012; Wenglinsky, 2005)

Technology plays a role in teaching physics. However, there is still need to study how to integrate technology into teaching and learning management that can support science teaching. (Osborne and Hennessy, 2003) it can be said that physics teachers lack of technological pedagogical content knowledge (TPACK), which is an important factor in effective learning management. TPACK is a theory which presents the relationships between the technological, pedagogical, and content knowledge of teachers and students. Mishra & Kohler (2006) define TPACK theory as the interaction and communication among these three types of knowledge. There are three interconnected components: technological, pedagogical, and content knowledge. Explanations regarding these are given respectively, as follows. Technological knowledge (TK), Pedagogical knowledge (PK), Content knowledge (CK), Pedagogical content knowledge (PCK), Technological content knowledge (TCK), Technological pedagogical knowledge (TPK), and Technological pedagogical content knowledge (TPACK). This is a challenge for teachers. Therefore, the understanding of problems in physics teaching and learning and the teachers' technological pedagogical content knowledge (TPACK) will be the basic information for use as a guideline for physics teacher professional development.

2. Methodology

This research is survey research that presents both quantitative and qualitative data. Using content analysis and descriptive statistics to analyze the data. This research aimed to 1) Investigate physics teachers' Technology Pedagogy and Content Knowledge.

(TPACK) 2) Investigate the Problems in the Physics Instructional Management in the Situation of Coronavirus Pandemic.

2.1. The participants

The participants were 16 in-service teachers who under the secondary educational service area office Sukhothai.

2.2 The research instruments

The research instruments in this study include

1. Questionnaires on learning management problems and level of TPACK of physics teachers. The questionnaires are an open-ended question divided into 3 parts as follows:

Part1 Question about teachers' basic information such as gender, age, teaching experience.

Part2 Question about the level of teachers' TPACK.

Part3 Question about problems with teaching and learning management.

2. Semi-structured interview. It was an interview for in-depth information after a physics teachers answered a questionnaire.

Researcher brought all of research instruments to the experts for checking the suitability then used to collect the data.

2.3 Data analysis

Researcher analyzed the data from the questionnaires and interviews by using content analysis. To analyze the data from the questionnaire, researcher compiled the data and grouped the data obtained to create conclusions on various issues. The level of teachers' TPACK questionnaires applied from Schmidt et al. (2009) and Tzu-Chiang Lin et al. (2012) and using likert Scale for analysis the data. The analysis of the data from the interview, researcher start with a transcript of the interview tape then organize information to group the data and make a conclusion and see the consistency with the data obtained from the questionnaire. Peer debriefing was used for ensure the trustworthiness in this study.

3. Research Findings

3.1. Preliminary information of the respondents.

16 physics teachers from schools under the Sukhothai Secondary Educational Service Area Office. There were 5 males and 11 females. Classified by educational qualifications, they can be divided into 2 groups: 7 teachers graduated from a faculty of science degree and 9 teachers graduated from a faculty education degree. Classified by age, it was found that there are 3 teachers in range of 22-25 years, there are 4 teachers in range of 26-35 years, there are 8 teachers in range of 36-45 years, there is 1 teacher in range of 45-60 year. Classified by teaching experience can be classified as 1-2 years physics teaching experience had 3 people, 3-10 years had 6 people, 11-20 years had 6 people and more than 20 years, there is 1 person. and classified by grade level, there are 6 teachers is in grade 10, there are 5 teachers is in grade 11 and there are 4 teachers is in grade 12.

3.2. Technological Pedagogical Content Knowledge

Teachers' technological pedagogical content knowledge in each component follows Mishra and Koehler (2006) framework. There are 7 components of TPACK, Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Technological pedagogical content

knowledge (TPACK or TPCK) by showing the frequency and percentage in each component. The details are follows table 1

Table 1: The frequency and percentage of teachers' TPACK

Level	Mean score and percentage of teachers' TPACK													
	CK		PK		PCK		TK		TPK		TCK		TPACK	
	f	%	f	%	f	%	f	%	f	%	f	%	f	%
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Low	1	6.25	1	6.25	0	0	2	12.50	1	6.25	3	18.75	7	43.75
Medium	10	62.50	9	56.25	9	56.25	7	43.75	9	56.25	8	50	5	31.25
High	5	31.25	6	37.50	6	37.50	5	31.25	5	31.25	5	31.25	3	18.75
Highest	0	0	0	0	1	6.25	2	12.50	1	6.25	0	0	1	6.25

Content Knowledge (CK)

It was found that there are 10 teachers (62.50%) had moderate level of content knowledge, 5 teachers (31.25%) had a high level of content knowledge, and 1 teacher (6.25%) had low level of content knowledge.

Pedagogical Knowledge (PK)

It was found that there are 9 teachers (56.25%) had moderate level of pedagogical knowledge, 6 teachers (37.50%) had a high level of pedagogical knowledge, and 1 teacher (6.25%) had low level of pedagogical knowledge.

Pedagogical Content Knowledge (PCK)

It was found that there are 9 teachers (56.25%) had moderate level of pedagogical content knowledge, 6 teachers (37.50%) had a high level of pedagogical content knowledge, and 1 teacher (6.25%) had highest level of pedagogical content knowledge.

Technological Knowledge (TK)

It was found that there are 7 teachers (43.75%) had moderate level of technological knowledge, 5 teachers (31.25%) had a high level of technological knowledge, 2 teacher (12.50%) had highest level of technological knowledge and 2 teacher (12.50%) had low level of technological knowledge.

Technological Pedagogical Knowledge (TPK)

It was found that there are 9 teachers (56.25%) had moderate level of technological pedagogical knowledge, 5 teachers (31.25%) had a high level of technological pedagogical knowledge, 1 teacher (6.25%) had highest level of technological pedagogical knowledge and 1 teacher (6.25%) had low level of technological pedagogical knowledge.

Technological Content Knowledge (TCK)

It was found that there are 8 teachers (50.00%) had moderate level of technological content knowledge, 5 teachers (31.25%) had a high level of technological content knowledge, and 3 teacher (18.75%) had low level of technological content knowledge.

Technological pedagogical content knowledge (TPACK)

It was found that there are 7 teacher (43.75%) had low level of technological pedagogical content knowledge, 5 teachers (31.25%) had moderate level of technological pedagogical content knowledge, 3 teachers (18.75%) had a high level of technological pedagogical content knowledge, 1 teacher (6.25%) had highest level of technological pedagogical content knowledge.

3.3. The Physics Instructional Management.

Researcher presents the scenarios of physics teaching and learning in the situation of the corona virus pandemic. The problems were divided into 3 aspects: 1) The aviability of the equipment. 2) The presence of students and teachers. and 3) Physics learning management. The details are follows:

1. The availability of the equipment.

It was found that there were 2 problems, the first issue related to the equipment that used in learning. Students do not have learning equipment to use for online learning, such as mobile phones, computers, notebooks, and iPad. Causing students unable to study normally. As shown in the example of the teacher's answer as follows:

"Students are poor. They do not have equipment for study."

(Teacher, answering the questionnaire, January 2022)

"Students have unavailable online learning materials."

(Teacher, answering the questionnaire, January 2022)

"Sometimes we understand students. They don't have the learning equipment to use for online learning. Maybe I have to teach them later."

(Teacher, telephone interview, January 2022)

The second issue was the internet system. It was found that the internet was unstable in some areas, causing the teaching to be unstable. As shown in the example of the teacher's answer as follows:

"The internet for both teachers and students are unstable."

(Teacher, answering the questionnaire, January 2022)

"The online device is not ready. There is no internet."

(Teacher, answering the questionnaire, January 2022)

"Teachers and students' devices are not ready to use for online learning. There are no devices that support online learning. There is no internet package to support the study."

(Teacher, answering the questionnaire, January 2022)

2. The presence of students and teachers.

Regarding the presence of students, it was found that the students did not concentrate on online learning, lack of responsibility for attending online classroom, the environment is not conducive to studying. As an example of the teacher's answer as follows:

"The availability of students is insufficient. When they study at home, the environment is not suitable for learning."

(Teacher, answering the questionnaire, January 2022)

"The interest and discipline in attending online classroom has decreased. Cause they lack of responsibility in learning."

(Teacher, answering the questionnaire, January 2022)

Regarding the presence of teachers, it was found that because it was a new teaching style, they don't habitual for online teaching and most of teachers cannot use technology in their teaching. As an example of the teacher's answer as follows:

"Teachers do not have technology skill. Therefore, it is difficult to use technology for teaching and learning. At least, just open the video for students to watch or let students use it to search."

(Teacher, telephone interview, January 2022)

"I have tried not to lecture, but it's inevitable. I also try to use more technology for online teaching but, it will take time to adjust and study the further."

(Teacher, telephone interview, January 2022)

3. Physics learning management.

Schools use an online learning model through the Google Classroom platform, with most schools providing lecture-based instruction. For example, physics problems solving and let students practice problems solving by themselves. Some schools were demonstrating the experiments and ask questions to learn physics concepts. Some of schools are using technology to help manage physics learning, for example asking students to search the information from search engine, demonstration of experiments through various physics applications, etc. As an example of the teacher's answer as follows:

"Most of them will focus on lecture style and let students practice problems solving."

(Teacher, answering the questionnaire, January 2022)

"We tried to do experiment for showing students through the camera. Maybe open an experimental video or physics applications and discuss the results of the experiment together."

(Teacher, telephone interview, January 2022)

The problems encountered in teaching physics in the situation of the corona virus pandemic because the teaching and learning is an online. The problem is teachers are unable to organize activities for students to perform experiments. The student's participation in learning is reduced, such as expressing opinions, working together, asking questions, etc. As an example of the teacher's answer as follows:

"Teachers are not familiar with the method. It is difficult to communicate for students to understand. Some topic of physics content can do the experiment to show the concept, but they can't."

(Teacher, telephone interview, January 2022)

"Physics is a subject that needs to be explained and there are some experiments to help students understand better. There are also calculations that start from simple to complex calculations. Sometimes students do not catch up the idea and do not dare to ask during study."

(Teacher, answering the questionnaire, January 2022)

In addition, another problem is the assessment during the online teaching. The results showed that Teachers have difficult to create the assessment scales. Using an online exam could not truly measure students' knowledge because students can ask each other about the questions. Therefore, that make the result from the assessment results are inefficient and unreliable. As an example of the teacher's answer as follows:

"Evaluation is difficult because it is an online exam Students can copy the answers."

(Teacher, telephone interview, January 2022)

"There is no control over taking online exams. Students can find answers on the Internet.

(Teacher, telephone interview, January 2022)

From the research results, it can be seen that most of schools' teaching and learning style during the covid-19 pandemic is online. Therefore, the teaching and learning management of physics has completely changed. However, the level of teachers' TPACK depend on various factors. I will present of the level of Physics teachers' TPACK. The researcher presented in 2 issues with details as follows:

1. The level of physics teachers' technological Pedagogical Content Knowledge.

Start with content knowledge, most of physics teachers had moderate to high level of content knowledge. there are 5 teachers who have a high level of content knowledge. This is because they had graduated in faculty of science. They can understand physics concept perfectly. On the other hand, teachers who do not have a graduated in faculty of science but graduated in faculty of education found that knowledge of physics content was at a moderate level. But the knowledge of pedagogy knowledge will be at a high level. Teachers can organize teaching activities that are consistent with the content, able to bring students into the learning process appropriately, and able to follow the students' learning as well. But I'm not sure if we asking about who is better between the teacher who graduated in faculty of science or education. I think it's depended on teaching strategies and some learning management technic. that why most physics teachers had moderate to high level of Pedagogy Content Knowledge.

Technology knowledge, found that most physics teachers had moderate to high level of technology knowledge. Teachers have basic knowledge to use technology such as computers, internet, video media, etc. They also can learn how to use technologies. In addition, it was found that there are 2 teachers with a highest level of technology knowledge, it was found that these 2 teachers are assistant teachers. (22–25 years old) they can learn and access the modern technology is easier than older teacher. This is consisting with the research findings that there are 2 teachers with low level of technological knowledge, of which these 2 teachers are in the age range of 36-45 years. This is show that the age of teachers affects the learning of technologies, which will affect to the technology knowledge of each person. Also, consistent with Alison Gopnik (2019) that study of problem-solving learning among teenagers and adults. found that teenagers can learn better than adults. This is because teenagers have many different learning methods and strategies for learning. On the other hand, adults who tend to use traditional learning, if they find it difficult to learn and the methods, they use cannot learn it. They wouldn't want to learn. It also inconsistent with Alison Gopnik (2019) because there is 1 teacher who 45 year old have high level of technology knowledge. The data from teacher' interview found that. teachers are constantly improving themselves by learning to use new technologies through training or asking from teenagers in the school. That mean age doesn't have much effect on learning technology.

Technology pedagogy and content knowledge related to technology pedagogy knowledge and technology content knowledge. The research results, it was found that most teachers had moderate level of knowledge in these two areas. They can facilitate students to use technology to find out more about their learning. They can facilitate students to use technology in planning and follow up on their own learning. They can facilitate students to use technology to create various forms of knowledge representation, etc. In addition, they can use software created especially for science. They have technology knowledge that required for teaching and learning science content. However, when teachers have to combine technology, teaching methods and physics content together. It is going to be difficult for them. This is consisting with research findings that show that most physics teachers had low level of technology pedagogy and content knowledge. This is because teachers are accustomed to teaching in normal situation. In other words, teachers often use lecturing and experimental that relies on the tools and experimental equipment in

schools. But when teaching and learning management have changed to an online, teachers have to change the way of teaching and learning. causing the teacher become unfamiliar and don't know how to start. It consists with Guzey, S. S., & Roehrig, G. H. (2009) they study of teaching science through technology. It was found that teachers were unable to integrate technology into learning management because they lack of familiarity using technologies that specific with content. Unable to decide how and when to use technology to manage learning. Teachers have no background in using technology and do not know how to solve the problems when technology do not work. Therefore, they do not dare to use technology in their teaching.

In addition, the researchers had interviewed teachers for more information about using technology in their teaching. The result show that although teachers have used technology but, the use of technology is not used in the form of integration into teaching and learning physics. It is only used as an online classroom platform. The teaching process still focuses on lectures as before.

4. Conclusion

While the corona virus pandemic schools under the Sukhothai Secondary Education Service Area Office. All of schools offer online teaching and learning. But, also use another learning style such as on-demand, on-air, on-hand. There are 3 parts of problem in physics teaching and learning in the situation of the corona virus pandemic. 1) The availability of the equipment. 2) The presence of students and teachers. 3) Physics learning management. However, online teaching management during covid-19 situation will success is depended on the presence of many factors as a driver, including the availability of teachers and students, context of content, learning materials, learning management process, communication system, information technology network system, and learning achievement evaluation. (Wittaya Wayo et al., 2020)

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6. References

Anupong Kanthiwong. (2020). Creating Multiple Choice Exams for Online Exams in the Situation of COVID-19 pandemic. *Army Medical Practitioner*, *73*(2), 125-129.

Alison Gopnik. (2019). "Kids are smarter than adults when solving certain problems" *berkeley research university of California.*

Cunningham, C. M., & Carlsen, W. S. (2014). Teaching engineering practices. *Journal of Science Teacher Education, 25*(2), 197-210.

Goldfarb, A., Pregibon, N., Shrem, J., & Zyko, E. (2011). Informational brief on social networking in education. Emerging Teaching & Learning Technologies Initiative. *New York Comprehensive Center*, Retrieved April, 26, 2013.

Guzey, S. S., & Roehrig, G. H. (2009). Teaching science with technology: Case studies of science teachers' development of technology, pedagogy, and content knowledge. *Contemporary Issues in Technology and Teacher Education, 9*(1), 25-45.

Matthews, M. R. (1997). Science teaching: the role of history and philosophy of science. *New York: Routledge.*

Osborne, J. and Hennessy, S. (2003). Literature Review of ICT: Promise, Problems and Future Directions. *Bristol: Futurelab.*

Pruekpramool, C., and T. Sangpradit. (2016). Teaching physics in english: a continuing professional development for non-native english-speaking teachers in Thailand. *Journal of Education and Learning, 5*(2), 47-59.

Sadler, P. M., and Tai, R. H. (2001). Success in introductory college physics: the role of high school preparation. *John Wiley & Sons, Inc.*

Savasci, F., & Berlin, D. F. (2012). Science teacher beliefs and classroom practice related to constructivism in different school settings. *Journal of Science Teacher Education, 23*(1), 65-86.

Thammarat Saeton. (2021). The presence for online teaching of students under the COVID-19 epidemic situation : a case study of Prince of Songkla University Phuket Campus. *Journal of Multidisciplinary Academic Research and Development,* Vol. 3 No.2, 2021

Wittaya Wayo et al. (2020). Online teaching and learning under the situation of COVID-19 pandemic: concepts and applications of teaching and learning. *Journal of Health Center 9: Journal of Health Promotion and Environmental Health. 14*(34), 285-298