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Science Pre-service Teacher Reflection on Pedagogical Knowledge and other Essential Practical Skills Needed for Practicum according to School Context in Thailand

Thidaporn Souysaart and Pairoh Sohsomboon
Faculty of Education, Nakhon Phanom University, Nakhon Phanom, Thailand
Email: thidaporn1986@npu.ac.th

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Abstract. This study focused the views of 38 science preservice teachers on their concern during practicum experience in Thai school context. Written reflection and non-structured interview during group seminar were utilised to construct an idea of science preservice teacher concern on their practicum experience. Qualitative method was implemented to understand and illustrate circumstances of the phenomena. Data were inductively categorized into 8 themes of the science preservice teacher' concern refereeing to 4 aspects, classroom instruction, social resilience, school condition, and other assigned academic work from school and university. The finding reveals the essential condition of quality experience during education programme to support effective practicum experience in Thailand, which has to consider various dimensions not only practical knowledge and skills for classroom instruction but also other dimensions such as communication, social value and culture.
Keywords: science pre-service teacher, pedagogical knowledge, practicum

1. Introduction

In Thailand, there is an organization monitoring teacher education so-called the Office of the Educational Council by the Secretariat Office of the Teachers' Council of Thailand (2015). Candidate teachers have to obtain their practicum experience through their teacher education programme. Such programmes aim to develop the knowledge, skills and attributes of preservice teachers in order to prepare them to be an effective teacher and meet all requirements needed of school context.

The practicum is accounted as indeed crucial phase for teacher education where preservice teachers initially attain chances to apply and practice the practical knowledge and skills that they have learned in their teacher education programs to the real school environment (Barton et al., 2015). Having said that, practicum is believed to offer valuable experiences to support candidate teachers in preparing them to meet the needs of actual classroom and school context for prospect teachers (Phromsa-ard, 2019). Preservice teacher conceives lacking of experiences of the real context, so that it is essential for them to gain practical knowledge and skills in all perspectives in order to be able to response to the assigned task such as instructional and some other tasks from school context (Roehrig et al., 2007) as being teacher in the real world does not mean they have to connect solely with classroom instructional, teacher also have other aspects of work in school depend on school context.

Practicum is undeniable that challenge and stressful endeavour for many preservice teachers to initially implement knowledge into practice (Gardner, 2010). Studying viewpoint of preservice teacher during practicum experience might allow educators to understand the preservice teacher concern as the preservice teachers are in the position to explore themselves related to context (Caires & Almeida, 2012; Husin et.al., 2021). Studies on initial teacher preparation programs often aimed at technical/cognitive growth of preservice teacher (e.g., scientific, pedagogic or subject matter knowledge). However, it seems that fears and doubts realized during the practicum provides a vital opportunity for teacher educators in supporting preservice teacher essential knowledge and skills, emotional and moral growth in the preparing period of the teacher profession (Poulou, 2007; Thongnoppakun and Yuenyong, 2019). Doubts, fears and dilemmas experienced during the practicum are seen important and, hence, studied by several researchers, though with some other alternative terms such as challenges (Koc, 2012) concerns (Goh & Matthews, 2011; Poulou, 2007). However, research on teacher education regarding practicum often focus on teaching practice (Goh & Matthews, 2011; Poulou, 2007; Nuangchlerm, 2009). The factors generating stress during practicum should be identified and necessary precautions should be taken to minimize their occurrence, thus, pre-service teachers can make effective use of practicum (Celik, 2008; Sutaphan and Yuenyong, 2021).

Direct experience from the practicum in combination with opportunities to reflect critically on the experience and emergent problems in the real-world context would be able to assist teacher education in the sense of understanding their need and concern for practicum or prospect teacher (Jantrasee et al., 2018). More than that critically reflection on practicum experience would be benefit for preservice teacher themselves as it believed that the process of reflection would stimulate them to gain self-evaluation and self- awareness for being effective teacher. As they release their weakness, the preservice teacher would aware of that and would stimulate the need for improvement.

It is important for both course-work and practicum be recognised as essential context for preservice teachers to learn about their knowledge and skills that support teacher profession. It seems to be worth addressing the concerns of students related to their teaching practice experiences as gaining more detail on the practicum experience would ensure that the teacher education programmes will attempt to manage programme to meet the goal of effectively preparing preservice teachers for being prospect science teacher in school environments (Poulou, 2007) by minimizing the sources of concern and maximize the benefits of teaching practicum (Caires and Almeda, 2005).

The Faculty of Education, Nakhon Phanom University responsible for teacher education in Northeastern region. The division of science education has prepared for science teacher development to the educational service. Science teacher educational programme essentially gain practical knowledge and skills to prepare the preservice teacher for effective prospect science teacher. Hence, this study will attempt to explore and address science preservice teacher' concern on the experiences during their practicum experience. The result of this study is expected to be light for teacher educator on effectively preparing professional development knowledge and skills for science preservice teacher.

2. Methodology

This study is aimed to explore the concerns on practicum experience of science preservice teacher from faculty of education, Nakhon Phanom University, Thailand. Teacher education in Thai context, Secretariat Office of the Teachers' Council of Thailand (2015) has prescribed in curriculum that preservice teacher has to gain experience on practicum for one year as the practicum should be long enough to better prepare pre-service teachers for their careers. Teacher preparation programs, recently, lasted for four years. Practicum course at Faculty of Education, Nakhon Phanom University is provided in two practicum courses in two semesters, the second semester of the third year and first semester of the fourth year. Before that teacher students enroll school experience in their first and second year already. The school experience course is aimed students to observe and get acquaintance with the school environment whereas practicum course expects preservice teacher to teach at least 8 hour a week and conduct the other work as they are teacher in the school. Science preservice teacher will spend about 2 months in the school for first practicum course. This study collected data on the second semester of the third-year science preservice teacher in 2021 academic year. These preservice teachers have been prepared under science education curriculum in all aspects for prospect science teacher include subject matter courses, general education courses and practical pedagogy as well as the ethics of the profession expecting preservice teacher to implement in the practicum. The practicum does not provide only an opportunity for preservice science teachers to plan and teach science lessons in the classroom but also learn other context related to professional teacher in actual school environment. Preservice teacher will have to work with experience in-service teacher, cooperating teacher, and university supervisor as facilitator to guide and support during the practicum. Group seminars related to practicum are the primary data sources for the study at the end of practicum course.

Purpose of the study

This study aims to explore and describes preservice science teachers' views on their own practicum relating to their concern.

2.1 Research Design

This study implemented qualitative research on interpretative paradigm to understand the context of SPT experience (Cohen et al., 2000, Creswell, 2014). This research is aimed to understand and address pre-service teachers' concerns during their practicum. Preservice teacher concerns were elicited by means of group seminar after first semester practicum has finished. At the end of the practicum experiences, participants were asked to prepare a final reflection, which was designed to encourage participants to reflect on and discuss the success and problems they experienced throughout the practicum. The preservice teacher's concern written and narrative reflections were subjected to content analysis. Qualitative data was collected by written reflections, and narrative reflection on group seminar was audio-taped then transcribed for the analysis to construct a picture of the experiences of preservice science teachers to identify how they succeeded, struggled and learned as a part of their practicum.

2.2 Participants

Participants were 38 preservice science teachers enrolled in the practicum course at The Faculty of Education, Nakhon Phanom University, Thailand in 2021 academic year during their second semester of their third year.

2.3 Data collection instruments

The instruments utilized for data collection in this study included questions for written reflection on group seminar after the practicum. Four questions compose of (1) What aspects that they need (expect) serving from teacher education programme in university to emphasis more for effective science teacher profession (2) what are their worries during their practicum experience (3) What aspects that they have to develop for being professional teacher (what are their weaknesses that they consider to overcome) (4) What are obstacle or barrier on effective profession during their practicum experience were employed. All questions are intended to elicit information on preservice teacher concern during practicum according to actual experience in Thai school context. During the group seminar, there will be a non-structured interview further on some interesting points of the participants' reflection in order to encourage participants to elaborate their concern as they experienced it in more detail. Pseudonyms have been substituted for their preservice teacher names as SPT (Science Preservice Teacher) and there will be a number after abbreviation such as SPT1, STP2 refers to science preservice teacher number 1 and number 2.

2.4 Data analysis

Data analysis was structured on inductive thematic coding. The data analysis process in this study took place with a grounded, data-driven approach (Creswell, 2014) to coding and organizing information, eventually leading to emergent themes from the written data. During the analysis process two researchers worked together. At the initial stages, both of the coders worked separately then the theme were shared and discussed. The analysis continued with a detailed examination of samples in each theme. Emergent themes evolving around the codes were refined as the analysis progressed. The themes, codes and illustrative examples were critically evaluated until an agreement has reached.

3. Research Findings

The Science preservice teachers reflect their own practicum experience regarding their concern during practicum experience, the analysis led to determination of 8 main themes. The themes with their dominant and noticeable features will be clarified with illustrative quotations as follow;

Concern of Pedagogical Knowledge

Practicum offers preservice teacher the first chance to transfer pedagogical knowledge into practice, so that participants show anxiety toward pedagogical theories during the practicum experience in various aspects such as pedagogical method (instructional approaches and strategies), instructional media.

SPT illustrates their concern of their insufficient pedagogical knowledge on various approach to transfer scientific concepts in a different environmental context. Teacher education programme in the university have to sufficiently provide pedagogical knowledge for them in order to create various learning activities in different contexts.

> SPT3: "I want to gain knowledge on designing learning activities for different content. Like, when we see specific content, we know straight away what approach or activities we should design for this content."

Preservice teacher also refers to knowledge on designing interesting worksheets to captivate student's attention rather than worksheets from a book.

> SPT1: "I want to gain more knowledge on the teaching approach to stimulate student's interest in the lesson; I don't want to teach from the book only. And I want to be able to create interesting worksheet for students as I notice that colorful worksheets, having cartoon pictures in them, can draw student's attention into the worksheets. Students seem to enjoy working more than before"

The preservice teacher mentioned knowledge to compose rigorous instructional plan and sufficient knowledge to implement various approach appropriate for different content knowledge.

> SPT2: "I want to gain more knowledge of creating and designing instructional plan in various approach and cover different content knowledge. Like, when we see content knowledge then we could be able to design appropriate teaching strategies straight away."
>
> SPT6: "My cooperative teacher always uses 5E cycle approach for her instructional plan, and always follow the same path on her teaching, teaching from the book, watching VDO and doing the practice from the book. So that I want to be able to implement various techniques on my teaching and be able to design various techniques on the instructional plan rather than 5E cycle only."

Instructional media was abandoned, lecture method is still usually used in science classroom from cooperating teacher so that the preservice teacher desire to gain more knowledge on creating and designing instructional media or designing experiment activities to stimulate students' interest for students to participate in the lesson rather than only talk and chalk technique.

> SPT1: "I wish I could have sufficient knowledge and ability to create and design various instructional media to stimulate student's interest as students used to with lecture method leaning from book and power point presentation"
>
> STT4: I notice that my cooperative teacher does not implement much pedagogy in her teaching as she follows book nothing else on her teaching and assigned practice from the book or watch VDO but there was no experiment implemented. So, what I want more is knowledge to create instructional medias or experiment for students."

Preservice teacher mentions pedagogical knowledge implemented for individual different of students.

> SPT5: "As I have to teach 3 different classes, and students have in each class are different. Students in the first and second class attain good background knowledge whereas students in the third class are not fast learners. So, I want to be able to implement different techniques for different type of students. I want to be able to implement different techniques for different kind of students."

Science preservice teachers express their concern on many aspects of pedagogical knowledge such as instructional approach, instructional technique, instructional media, instructional plan, designing experiment but assessment. Although, all pedagogical knowledge concerned has been taught in teacher education programme, it has not really been practiced in the real-world situation.

Concern of Subject Matter Knowledge

Science preservice teacher illustrate their concern about incorporating indigenous science knowledge for science classroom.

Preservice teacher seems to worry about insufficient subject matter knowledge to transfer to student as they have to explain body of knowledge. And they also express their concern about the process of preparing content knowledge for their lesson.

> SPT11: "We need to be precise on the content knowledge that we teach, I quite worried not to be able to explain that content knowledge clearly and accurately, if students will understand about the content knowledge I explain to them. I worried if the knowledge I explain to students is accurate."
>
> SPT5: "I worry about subject matter as I teacher secondary students, I have to prepare about content knowledge that I have to teach. I have to transfer

> the content knowledge to students. I worry how would I explain that knowledge for students and make them understand it"
>
> SPT3: "I have to prepare more about the content knowledge, make myself to understand the knowledge in order to teach students to understand it easily. I have to understand deeply in order to monitor students learning, if they answer correctly when they do activities. Like, when we have to transfer knowledge for students to understand but I feel that I am not yet be able to explain the content deeply, I worry if I understand the content enough to explain for students correctly."

Preservice teacher worries of having insufficiency subject matter knowledge to transfer to student in order to be able to answer student's questions from students in their teaching.

> SPT7: "There are number of questions on science content knowledge which related to fact but sometime the questions from students are from their experience such as from cartoon. Sometimes there are questions that I cannot answer."
>
> SPT11: "We need to have precise science content knowledge on the topic that we teach, we have to prepare and study if we are not sure about it as when students ask, we have to be able to answer to students' questions."

Preservice teacher refers to their worried about thinking of knowledge implication in everyday living.

> SPT9: "We have to think about linking science content knowledge with situation in everyday living whether the science content that we teach will be able to apply in student's daily live so that it will be easier for students to remember the knowledge"

It seems that students do not have confident on their knowledge of subject matter as they view science content knowledge as body of knowledge and they have to understand everything in order to answer student's questions.

Concern of Classroom Management

Classroom management seems to be one of the most concerned aspects of science preservice teacher during their practicum.

Classroom management has become a real concern for many SPT especially when they realised the mentor difficulties from some students:

> SPT20: "LD (disorder learning) students pay no attention on the lesson; they always talk and play. They even induce and persuade other students to play. It is really difficult to central LD students into the lesson. Some students forget to take their daily pills lead to misbehave, run around the classroom."

Participants express the concern on their own teaching time management.

> SPT5: "I worry of how to manage time about the content that we teach as science content is complicated and huge."

Another point in concern of classroom management is about time management on their teaching consequence from students.

> SPT2: "Students often get to the classroom late, for example 10-15 minutes late, consequent less time for classroom teaching so I could not be able to manage the lesson to achieve indicator in the instructional plan."

Participants mention their concern on classroom management regarding students misbehave. Sometime, as they are preservice teacher they did not receive respect from students.

> SPT6: "I want to have idea and knowledge to manage the classroom regarding students misbehave. I worry if I could deal with it when I confront with this kind of students."
>
> SPT9: "As I am the preservice science teacher, students are not really listening or paying attention when I teach, some time they even bring the work

> from other subjects such as Thai language, English language, to work during the lesson I am teaching science."

Participants express concern about student's attention to the classroom, so they need to gain understanding and knowledge to manage this.

> SPT11: "I need more idea about classroom management. As when I teach in front of the classroom, students will pay attention on the lesson about first 5-10 minutes of the lesson. After that they will have loud chat and play, the classroom quite chaos. I tell them to be quite and pay attention to the lesson, they stop talking for about 3 minutes then the classroom goes back to the chaos. I need classroom management technique for my teaching."

Participants desire to gain knowledge on classroom management in various situations, they need guidelines to deal with problem solving in different situations.

> SPT7: "I want to gain knowledge on dealing with problems during instruction in the classroom. For example, in case students misbehave, I worry if I could manage the problem good enough."

As this practicum course was the initial actual experience of preservice teacher practicing their knowledge in the real classroom situation as they are individual different in human. Lacking experience might lead to fear and lack of confidence. In order to deal with situation, they need to gain an experience.

Concern of University workload

Preservice teacher has two dimensions of work, school context and university context. It seems that they really worry about the workload assigned to hand in to university supervisor after practicum in school has finished and they have to come back to study on other course works at the university.

> SPT24: "I worry about the workload that I have to finish during the practicum. To elaborate this, in practicum course, there are worked assign from the pre-service teacher practicum experience center from university and the work that we have to do at school during practicum."
>
> SPT11: "we have to spend only about 2 months for practicum in this semester but we have been assigned a lot of work from pre-service teacher practicum experience center such as the report which I think this extra workload is quite a lot. And more than that, after 2 months practicum we have to come back to study other course works at the university, so it makes me worry."

This concern reveals that they are not really able to focus on their classroom as they have to work in many aspects (work to hand in for university, and work for their further coursework). It is interesting point for the university to consider and improve this aspect to minimize student's stress.

Concern of Classroom Research

One of the assigned tasks for science preservice teachers on their practicum experience is science classroom research. The first course of practicum experience, science preservice teacher is assigned to attain a proposal of the classroom action research.

Participants express their concern on determining the topic of action research.

> SPT18: "I worry about classroom research because there was online teaching during my practicum experience. And I think that I have to observe the classroom in order to frame problems for my classroom research but there are not many things to observe as not many students attend the online teaching. So, it is more difficult for me to scope the topic for my classroom research."
>
> SPT35: "I worry about classroom research as time limitation and online teaching. Sometimes, there was only 5 students in the online

> classroom, and I do not really know where and how to focus on the classroom observation for classroom research. What skills that students lack of, like that."

The naïve expression form participants reveal a lack of experience in conducting research and think of the idea of a topic for classroom research.

Concern of Covid-19 Pandemic Situation

It is undeniable that the Covid-19 pandemic situation has an impact on teaching management. There was concern about teaching management during the situation both online and school dimension.

In case of teaching management in school, participants mention that keeping social distance they had to divide students in one classroom into two sections resulted in confusing in teaching schedule and learning activities as there were government holidays and school activities mess up teaching schedule.

> SPT7: "I am responsible to teach 7 sections, according to pandemic covid-19 situation, students in each section have to be divided into 2 groups, which means I have to teach 14 groups. Usually, I teach science 2 hours a week so I would be able to teach science to each group for 1 hour. So, it is very difficult to manage to teach them through the same level of topic. And sometimes, students themselves could not manage their learning."
>
> SPT9: "In the pandemic situation, school will divide one section students into 2 groups, these groups come to school on different days. For example, group1 comes to school on Monday, group2 comes to school on Tuesday. Sometime I barely see students in certain group result from government holiday and school activities, and it affect my teaching plan and schedule."

In case of online teaching, participants were not prepared for this situation, so they illustrate suffering from teaching management through online means as it is difficult to draw students' attention and monitor through the online teaching. And more than that, participants refer to concerning about the difficulty of stimulating student's skills and knowledge.

> SPT6: "I think that online teaching does not support active learning for young students. I notice that students lose their interest through online teaching, and it leads to not attending online classes. This results in discontinuing learning for students, unlike teaching and learning in the classroom."

Participants relate online teaching with loosen student's competency.

> SPT:5 "Pandemic covid-19 situation, we have to manage the classroom into online teaching. I notice that online teaching does not support students' skills or even content knowledge in a continuous way."

Teacher educator programmes should consider to aspects of technological concern and should prepare candidate teachers to the benefit of technological, pedagogical, and content knowledge (TPACK) (Koehler and Mishra 2009).

Concern of School Condition

Many participants refer to workplace (infrastructure and facilities), and working conditions as a matter of their concern.

> SPT2: "There is no projector and laboratory material support working."
>
> SPT18: "There is no projector in the classroom that I teach, I need to borrow from another room when I really have to use it. There is no facilitator in the classroom to support teaching, there is only a blackboard in the classroom. When I really have to do an experiment, I have to bring all laboratory glassware to the classroom that I teach, it is not convenient."

SPT4: "There is limited laboratory materials, some students cannot get to experiment, teacher have to demonstrate instead of students doing the experiment. There is no projector to support teaching, I need a projector to present my PowerPoint."

Moreover, other activities in school also concern science preservice teacher practicum experience as they affect teaching schedule.

SPT24: "There are many school activities and it leads to limited teaching time."

Participants get used to the teaching style by means of PowerPoint presentation and doing experiments in the laboratory which is induced from university. Preservice teacher should attain fruitful teaching means and mindset to be able to flexibly design teaching methods regarding the context of their work.

Concern of Social adaptation and resilience

Preservice teacher illustrates concern of adaptations and interactions with members of school community

SPT2: "My concern during practicum was that I was worried about communication with teachers and students in school. I am not really certain in what kind of vocabulary is appropriate to communicate with teacher and student"

SPT5: "I am not sure how to approach and communicate with my cooperating teacher."

SPT14: "…there was a situation where I was asked to deliver the exam paper to the teacher, there was no message with it so I am not sure what to say when I deliver it. I do not know how to communicate in a formal way. I am really worried about social adaptation with the new working environment."

Thai culture especially in schools where there is strongly hierarchy culture, students are on a different level with teachers, they have to pay deep respect for teachers. Even in the teacher community, young teachers have to pay respect to senior teachers. So as preservice teacher who was a student and has just become candidate students, it might be difficult for them to overcome the barrier of this hierarchy. School culture in Thailand does not focus on academic work where members in the community are at the same level.

4. Conclusion

The finding of this study provides important insights into the notion of SPT concern on their practicum experience and it suggests that direct experience from practicum lead to their consideration of practical knowledge and skills for being prospect teacher. The finding reveals that STP concern led to different interrelated categories including content knowledge, pedagogical knowledge, classroom research, infrastructure and facilities (school environment condition), classroom learning management, other work load, online teaching situation, and social adaptation. SPT concern led to fruitful opportunities for SPT to develop themselves as they also composed of self-evaluation and self-awareness process.

In term of ongoing discussions on the development of effective teacher preparation programmes, SPT concern in this study reveals that the participants are insecure of confident in knowledge implementation, although they have learned all essential knowledge and skills from teacher education programmes. It might infer that the teacher preparation course should address more on knowledge implication and real situation practicing for preservice teacher to embed their confidence on classroom instruction and classroom research, and to expose them to the experience of their real-world teaching situation.

Regarding participant concern about online teaching, teacher education programme should consider the importance of technology combined with pedagogical knowledge. TPACK should be utterly prepared to the most benefit of technology to teaching method for preservice teacher in the technological era.

Another crucial point is that SPT concern seems to represent that the experience from university implants their concrete mindset on teaching science. For example, many participants mention the term "transfer knowledge" rather than thinking of setting an environment for students to construct knowledge (Tobin, 1993). This kind of mindset led participants to frame the importance of body of knowledge and they have to answer questions correctly as an authorized person. Concern about not having a projector and laboratory is also the example of inducement from teaching in university as they have been taught in this way so they look for something that they are familiar with. To minimize this concern, students' mindset should be paradigm shifted from positivist to constructivist.

5. References

Barton, G. M., Hartwig, K. A., & Cain, M. (2015). International students' Experience of Practicum in Teacher Education: An Exploration through Internationalisation and Professional Socialisation. Australian Journal of Teacher Education, 40(8), 9

Caires, S., & Almeida, L.S. (2005). Teaching practice in initial teacher education: Its impact on student teachers' professional skills and development. Journal of Education for Teaching, 31(2), 111-120. https://doi.org/10.1080/02607470500127236

Caires, S., Almeida, L. & Vieira, D. (2012). Becoming a teacher: student teachers' experiences and perceptions about teaching practice. European Journal of Teacher Education, 35:2, 163-178. https://doi.org/10.1080/02619768.2011.643395

Celik, H. (2008). Pre-Service EFL teachers' reported concerns and stress for practicum in Turkey. Education and Science,33(150), 97-108.

Cohen, L., Manion, L. & Morrison, K. (2000). Research methods in education. New York: Falmer Press.

Creswell, J. W. (2014). Research design: qualitative, quantitative, mixed methods approaches (the 4th edition). Thousand Oaks, California: Sage Publication

Gardner, S. (2010). Stress among prospective teachers: A review of the literature. Australian Journal of Teacher Education, 35(8), 18-28. https://doi:10.14221/ajte.2010v35n8.2

Goh, P. S., & Matthews, B. (2011). Listening to the concerns of student teachers in Malaysia during teaching practice. Australian Journal of Teacher Education. 36(3), 92-103.

Husin, W. N. F. W., Husin, W. N. S. W., Arsad, N. M., & Halim, L. (2021). Competencies of Science Facilitators in Non-formal Learning Contexts. Asia Research Network Journal of Education, 1(3), 164–178. Retrieved from https://so05.tci-thaijo.org/index.php/arnje/article/view/255925

Jantrasee, R., Huntula, J., Sangsuwan, A., Sriboonlert, S. Saisang, J. & Kunachon, P. (2018). An analysis of pre-service science teachers' reflection of teaching practice. Journal of Science and Science Education, 1(2), 171-185.

Koç, I. (2012). Preservice science teachers reflect on their practicum experiences. Educational Studies. 38 (1), 31-38.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? Contemporary Issues in Technology and Teacher Education, 9(1), 60-70.

Nuangchlerm, P. (2009). Implementing Professional Experience to Prepare Preservice Science Teachers. The Social Science. 4(4): 388-391

Ozmantar, Z. K. (2019). A Phenomenological Study of Practicum Experience: Preservice Teachers' Fears. International Journal of Progressive Education, Volume 15 Number 1, DOI: 10.29329/ijpe.2019.184.9

Poulou, M. (2007). Student-teachers' concerns about teaching practice. European Journal of Teacher Education, 30(1):91-110. https://doi.org/10.1080/02619760600944993

Phromsa-ard, R., Meechan, S., & Charoensuk, O. (2019). A Proposal on Effectiveness in Efficiency in Counseling for Teaching Internship Students Faculty of Education Phuket Rajabhat University. (In Thai). Social Sciences Research and Academic Journal. 13(38): 119-134.

Roehrig, G. H., Kruse, R. A., & Kern, A. (2007). Teacher and School Characteristics and Their Influence on Curriculum Implementation. Journal Of Research in Science Teaching. The Official Journal of the National Association for Research in Science Teaching. 44(7): 883-907.

Saeleset, J. & Friedrichsen, P. (2021). Pre-service Science Teachers' Pedagogical Content Knowledge Integration of Students' Understanding in Science and Instructional Strategies. EURASIA Journal of Mathematics, Science and Technology Education, 2021, 17(5). https://doi.org/10.29333/ejmste/10859

Secretariat Office of the Teachers' Council of Thailand. (2015). Implementation of the Degree Certification Work and Educational Certificate for Professional Practice. (In Thai). Bangkok: Suksapan press. Bangkok, Thailand. ISBN: 978-616-7746-29-6

Sutaphan, S. & Yuenyong, C. (2021). Examine pre-service science teachers' existing ideas about STEM education in school setting. Journal of Physics: Conference Series 1835 (1), 012002

Thongnoppakun, W. & Yuenyong, C. (2019). Pre-service science teachers' professional learning through content representations (CoRes) construction. Journal for the Education of Gifted Young Scientists, 7(4), 1263-1275.

Tobin, K. (1993). The Practice of Constructivism in Science Education. Washington DC, USA: AAAS Press.