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Pre-service Science Teachers' Awareness of Knowledge and Skills for Inquiry Teaching during Their Teaching Practices in Schools

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Abstract. This study examined preservice science teachers' awareness of knowledge and skills for inquiry teaching during their teaching practice in schools. The participants were 3 preservice science teachers enrolled in a school internship course of Khon Kaen University (KKU) in order to practice their teaching in KKU Demonstration School (modindaeng). The KKU teaching practices course allowed these preservice teachers to practice their teaching for 2 semesters in the fifth year of their course. These 3 preservice teachers had finished their teaching practice at the secondary school level, in different schools, before they came to practice primary science teaching in the KKU Demonstration School. An interpretive paradigm was used for the research. Tools of interpretation included questionnaires, interviews, and participant observation. The findings clarified what and how the pre-service teachers learned and became aware of knowledge and skills for improving their teaching, with a focus on inquiry teaching. The paper will discuss their perceptions of problems and solutions for their teaching, pathways of gaining knowledge and skills for inquiry teaching, and the awareness they had of knowledge from 4 years of course work before taking part in these teaching experiences.

Keywords: Science teacher, awareness, knowledge, skills, inquiry teaching

1. Introduction

It should be noted that scientific literacy was an objective of Thai science education. The emphasis placed on scientific knowledge, the essence of science, and the connection between science and technology and society was the purpose. However, it appeared that rather than teaching science as a means of knowing, Thai education was mainly interested in the students' scientific accomplishments. Research, articles, national exams, and teaching and learning data from Thai science teachers revealed insufficient interest in science as a method of knowledge (Wongsila and Yuenyong, 2019; Yuenyong & Narjaikaew, 2009). Students should engage in inquiry in scientific classes in order to meet the objectives of Thai science education. Students who learn science through inquiry may be able to build their scientific thinking and construct the meaning of scientific concepts

as well as learn about the nature of science (Asay & Orgill, 2010; Thao-Do and Yuenyong, 2017).

Although teachers recognized the potential advantages of employing inquiry in a scientific classroom, there appeared to be difficulties in actually putting inquiry into practice (Abd-El-Khalick et al. 2004; Crawford 2000; Krajcik et al. 1998; Lee & Songer 2003). Many obstacles prevent teachers from implementing inquiry in the classroom. They were concerned that during inquiry-based activities, they wouldn't be in control of their classes. Time constraints prevent the allowed curriculum from being covered through inquiry. Or perhaps even students are incapable of conducting research projects experiences (Asay & Orgill, 2010). In order to provide powerful chance of scientific inquiry, teachers should gain knowledge and skills of providing scientific inquiry activities (Yuenyong et.al., 2015).

The majority of science teachers agreed that in order to achieve the purpose of science education, it is necessary to make science instruction more relevant by putting an emphasis on student-centered learning and lifelong learning that should take into account the relationship between science, technology, and society (Attapan and Yuenyong, 2019; Samranwanich et.al, 2016; Sohsomboon and Yuenyong, 2022). Many Thai teachers, however, continue to be unaware of the necessity for change. Instead of emphasizing practice and experience-based learning, science teachers place a heavy emphasis on theory, lectures, textbook reading, and teacher-centered education. In contrast to how information is applied to diverse educational purposes, they continue to place more emphasis on how much prospective teachers learn (Meedee and Yuenyong, 2021; Thongnoppakun and Yuenyong, 2019; Souysaart and Sohsomboon, 2022).

Even though this knowledge is frequently irrelevant to them and rarely used in the classroom, preservice science teachers learn how to memorize facts well from their courses. To achieve Thailand's goal of science education, science teaching and learning focused more on information than on opportunities for students to apply critical thinking, self-expression, and self-learning. When teaching science, science teachers may provide help by explaining the nature of science and how it relates to technology and society (Chanserm et.al., 2019; Sutaphan and Yuenyong, 2021). The skills of teachers need to be developed so that they may work as professionals who can identify the best approach and create lessons for various constructivist learning scenarios (Tupsai et.al. 2015; Udomkan et.al., 2015; Yuenyong and Thatthong, 2015).

Preservice program in Faculty of Education, Khon Kaen University (KKU) enhance students regarding NOS for him or her teaching. The program provided them science content, pedagogy, and pedagogical content knowledge during their four years of course work before school internship in the 5th year. Fundamentally, all preservice science teachers perceived to provide his or her class as scientific inquiry. They expected to know how to provide inquiry activities appropriate to science content and students' existing ideas and context. This study aimed to examine preservice science teachers' awareness of knowledge and skills for inquiry teaching during their teaching practice in schools. The study may suggest some issues of enhancing new preservice science teachers to construct their pedagogical content knowledge.

2. Methodology

Methodology was qualitative research that regarded narrative inquiry. Regarding on the narrative inquiry, the ways of helping people tell stories begin from a 'not knowing' position – rather than 'expert' position (Riessman, 2008). The narrative inquiry is story of preservice science teachers' awareness of knowledge and skills for inquiry teaching during their teaching practice in schools. Their drawing key aspect of knowledge and skills for science teaching as inquiry (5Es) will be questionnaires, interviews, and classroom observation.

2.1 Setting

The participants were 3 preservice science teachers (Suda, Piti, and Thorn) enrolled in a school internship course of Khon Kaen University (KKU) in order to practice their teaching in KKU Demonstration School (modindaeng). The KKU teaching practices course allowed these preservice teachers to practice their teaching for 2 semesters in the fifth year of their course. These 3 preservice teachers had finished their teaching practice at the secondary school level, in different schools, before they came to practice primary science teaching in the KKU Demonstration School.

The participants applied different kinds of science teaching strategies for inquiry such as Predict Observe Explain (POE), Inquiry Cycle (5Es), and Science Technology and Society (STS). However, the 5Es was held as fundamental preparing the lesson plan. An Inquiry Cycle (5Es) consists of five main stages, that is, engagement, exploration, explanation, elaboration, and evaluation (IPST, 2002). Engagement step allows 1) teacher introduces students to engage lesson within their interesting topics, and 2) students ask questions and determine issue to study. Exploration step suggests students plan and determine methods to explore or investigate their interesting topics. And, then, students set hypothesis, determine potential choices, and use various methods to collect data and information to test hypothesis. Explanation step is about fostering students to analyze and interpret data and information to derive results of study that may support or reject the hypothesis. Elaboration step asks students to elaborate and apply acquired knowledge by linking it with existing knowledge and using it to explain situations or events. And, evaluation step asks students to evaluate learning with respect to both processes and products of learning.

2.2 Tools of interpretation

The story of preservice science teachers' awareness of knowledge and skills for inquiry teaching was interpreted through Questionnaire of Reflective Teaching Practice (QRTP), interviewing, and classroom observation. The QRTP provided ten questions to ask preservice teachers at the end of second semester of school internship. These questions include:

1. Some of impressive thing during school internship
2. What problems do you have during school internship? How can you find the solutions for those problems?
3. What did you learn in school internship?
4. Did you find some appropriate ways for your science teaching when you applied 5Es for teaching? Why?
5. Did you find some advantages or problems for your science teaching when you applied 5Es for teaching? Please explain.
6. Are there any differences for applying 5Es in different school level (primary and secondary schools)? Please explain.
7. Which school level do you like to teach students as inquiry cycle (5Es)? Why?
8. What did you learn from experiences of school internship in different school level? Please explain.
9. Did one year of school internship provide you learn something more? Why?
10. What knowledge or courses in four years do you use as knowledge for your teaching practice in school internship?

Interview was carried out in order to probe pre-service teacher further what and how they understood after they completed the QRTP. Classroom observation allowed researcher could be able to interpret what preservice tried to reflect.

2.2 Data analysis

Data analysis was about what we gained from narrative knowing. Analysis was the interpretation of the QRTP, interview and classroom observation in order to provide a meaning making about the story of preservice science teachers' awareness of knowledge and skills for inquiry teaching. Then, the story was shaped in order to organize information about how preservice teachers' awareness of knowledge was constructed and reconstructed.

3. Research Findings

Three preservice science teachers' awareness of knowledge and skills for science teaching as inquiry will be clarify through 1) their perception about problems and solution in teaching practice, 2) influences of gaining knowledge and skills for science teaching as inquiry, and 3) awareness of lesson of 4 years course work as knowledge base for improving science teaching as inquiry.

3.1 Perception about problems and solutions in teaching practice

The Suda, Piti, and Thorn preservice science teachers' narratives reflected what they perceived about problems and solutions in teaching practice. Suda's narrative showed that she concerned about students' attention, difficulty of classroom management and pedagogical knowledge, solving school regulation about students' using internet. Piti' s narrative reflected that he concerned about teachers' social role in science classroom. Thai social role influence on classroom management. He also learned about the difficulty of taking the theory about pedagogy into practice. Thorn concerned about motivating students through media and difficulty of classroom management. These could be interpreted through Suda, Piti and Thorn' s narrative as following.

Suda' s narrative

My initial start, I felt, had some issues. I discovered that my expectations were not met by the actual classrooms. The students didn't appear to be listening to me. I was unable to inspire them. I'm at a loss for solutions to this issue. I enquired of the adviser to my school's teachers how I may proceed and what role I would play. …. Fortunately, I had familiar to students' behavior because I had some experiences from the previous school. Therefore, I was confident to act my teacher role. ….. The inquiry cycle approach to teaching science (5Es) has benefits. First, using the 5Es as a teaching technique for science could be beneficial because it aids students in discovering their own knowledge. Experiment activities allow students to learn the steps of activities and develop their own knowledge. Secondly, students have chance to practice science process skills and gain more attitude toward science. Thirdly, it motivated students to learn science. Students were not boring to learn science. ….. However, inquiry cycle (5Es) has also limitations. It could not apply for all topics. Finding learning activities or instructional media would be challenging if we were to apply the 5Es to science topics that do not include experiments. Activities of searching from internet could not motivate students any more. They didn't want to study by themselves. …. Students in Khon Kaen are not permitted to use the internet to conduct research; otherwise, they visit other websites. I chose not to search and instead gave them sheets. …… I knew that I should try to apply other inquiry approach. Other inquiry approach, like STS, has difficult for me. Students loved to role play but they didn't try to find the solutions of STS issues. When I taught about sound pollution, for instance, it appeared that I applied the STS approach through trial and error.

Piti' s narrative

Unlike students from outside the university, SMD students usually speak out something without carefully thinking. Students seemed to do not respect me. They may perceive that I was preservice teachers. I was not real teachers. ….. Students usually talked loudly

together and did not pay attention on my assignment. Short term of my solving problem was social punishment e.g., no teaching until the class readiness. My long-term solving problem was well preparing lesson plan e.g. provide more details of organizing the classroom, adapting my moody for fun, starting the classroom with exciting and funning activities. I believed that these activities could motivation or engagement students to learn science. The most importance for handle the classroom was clearly activities description. When students understood details or steps of activities, they knew what they should do. …. Some topics were hard to prepare lesson plan because it contains remembering contents. If we started to teach these topics with funning activities, it would motivate fifty percents of students. … I think that if we teach science through 5Es learning cycle, it would be good for students to learn science. The problem is difficulty of finding some activities related to students' everyday life for "Exploring stage." If we can provide activities which allow students to inquiry relating to their context, it will motivate them because they will know what and why they must do those activities.

Thorn's narrative

I had some problems about classroom management or controlling the class. I consult my school advisors, share my friends some ideas and learn techniques of classroom management from book and internet. I learned that I needed to know what students were interesting in order to provide motivating instructional media. … Science teaching inquiry through 5Es allowed students to learn themselves. They have chance to do experiments that enhance their understanding the scientific concepts rather than remembering. But, it's difficult to finish the lesson in time because of time consuming from individual differences and students' attention and self-regulation.

3.2 Influences of gaining knowledge and skills for science teaching as inquiry

Obviously, the Suda, Piti, and Thorn improved their skills about classroom management. They learned from practicing how to prepare some activities to motivate students. Strategies for motivation depend on students' age, nature of contents, and school contexts. Primary school students may like more funny activities but secondary school students like something different. Secondary school students may enjoy with teenaged style of language. They learned about different kinds of rewards between primary and secondary school students. Teaching strategies for scientific inquiry also need to be provided differently for primary and secondary school. Practicing in both primary and secondary schools situated them to know what preferring styles of teachers. Suda and Piti love to prepare scientific inquiry for a primary school student but Thorn prefer to do for secondary school students. Their narrative indicated that the steps of 5E inquiry regulated them how to prepare scientific inquiry activities. They aware of the different ways of communicating for different student graders. These could be interpreted through Suda, Piti and Thorn' s narrative as following.

Suda' s narrative

School internship allowed me to learn how to apply psychology for supporting students' learning, classroom controlling, and time allocating (classroom management). First coming to school, I spent amount of time for lesson plan writing because I had no ideas to put in the lesson plan. I got various ideas of constructing instructional media after I passed the first semester of teaching practice. …. When I had teaching experiences in primary schools, I became aware of intriguing games and activities that helped make my teaching more lively and motivating. Unlike, KKW secondary school, teachers could not provide only sheet for SMD primary students. Teachers must provide more activities for primary students. They may be boring when teachers ask too many questions. If they could not answer those questions, I think I will find other exciting activities. For example, if teacher provide primary students role play as Mo-luck fortune-teller, they may fun and be exciting. …. I am aware of school workload, responsibilities, and role model for students. I perceived that science teaching through 5Es inquiry cycle allowed students to set hypothesis, designing, and doing experiment, and drawing conclusion. Students may have positive

attitude toward science when they have chance to act like scientists. ….. However, 5Es seemed to be difficulty for primary students because they could not be able to draw conclusion. Students usually asked me how to draw conclusion. Then, I explained them to conclude regarding the experiment objectives. If they don't understand, I will probe more. ….. School internship in different grade and school allowed to learned nature of students and pedagogy for different topics. When I taught Grade 8 students (secondary school), it seemed to be difficult to provide experiment or hand on activities for biological concept. I, therefore, told students to follow the sheets. First week of second semester, I taught SMD primary students like what I did in KKW secondary school in first semester. I perceived that my students in SMD felt sleepy. I learned from my school advisor that I must put the game in scientific inquiring. Rewards also may motivate primary students. Even though Primary science teaching does not deal to amount of scientific concept like secondary school science, teachers have to spend amount of time for interesting activities. …. I may spend long time for teaching practice in order to obtain my goal. I hope that I could prepare my language for communicating to students, particular primary students. It's easy for me to communicate to secondary students because their age was not much different from me. I have also learned about teacher characteristics. I worried about my dressing during weekend. If students saw I wore blue gene short, what questions will students ask me in the next classes.

Piti's narrative

Strategies of primary science teaching are different from secondary science teaching. When I taught secondary school students, I could divide students into group by students' ID number. But primary science teaching should not be organized like that. I had to write the number on the table tennis ball. Then, students selected the ball for setting the group. … primary school teaching is different from secondary school teaching. For example, I may assign groups of secondary school students based on the number of students. To split primary school students into groups, however, we must consider what enjoyable and exciting activities should be offered, such as picking up a ball at random because each ball has a different number. … During my school internship, I developed my communication skills with young pupils. To make it possible for them to follow, I must give them a small portion of the story. … In order to keep my pupils interested every day, I need to set up my classroom with a variety of teaching methods for each individual class. And, I must carefully think about if those teaching methods fit to the nature of topics and students. … I also gained work experience in Thailand's schools. In addition to teaching science, I am also responsible for running homeroom, planning school camps, and planning events for significant Thai holidays. Running homeroom allowed me to understand my students' behaviors. These activities teach me how to solve the problems that I never study before in the university. … I think that 5Es could not be used for all topics. I think it should be used when we will teach some topics that have to provide some experiments. … However, I have to write my lesson plan through 5Es even though it is not appropriate topic such as topic related memorized content. … First semester, I taught Grade 7 and then I taught Grade 6 in second semester. I learned that the nature of the activities is not very different. Because the children are around the same age The difference is that secondary school Grade 7 content is more difficult than primary school Grade 6 and can teach more profound areas. Science teaching through 5Es could more motivate Grade 6 students than Grade 7 students. The reason of this story may relate to science content. Grade 7 students need to learn more deeply content than Grade 6 students. … I love to teach science as inquiry for Grade 6 students because I can easily find the right activities to engage student to investigate with fun. However, managing a seventh-grade classroom is simpler than a sixth-grade one. …By the way, one year of practicing my teaching in school allowed me to learn how to communicate to students.

Thorn's narrative

I learned that school practicing is not only teaching but also various kinds of school working such as academic office, administrative work, school registration work, and so on. These kinds of job are things that I will do when I become actual teacher. … I love more

> teacher job when I am practicing in school. … I aware of the different kinds of students in different grade level. And, same Grade in different school also have different kinds of students. … I think the 5Es foster me to find the appropriate ways of preparing my science learning activities. … I taught secondary school students in the first semester and primary school students in second semester. I think there are some different issues of teaching between secondary and primary school. As primary school teacher, I must be careful my demeanor of the teacher. My wording and gestures should be good role model for students. And, I must act as lovely and nice teacher all the time when I am teaching primary school students. Instructional media for primary school student is different comparing to secondary school student. Because secondary school students are older than primary school students, managing a secondary classroom is simpler. My classroom is chaos when I teach science with 5Es teaching for primary school students. … Because of my teaching in both primary and secondary school, I understood what and how should I prepare my teaching for different student graders. I must prepare a game for my science teaching in primary school.

3.3 Awareness of lesson of 4 years course work as knowledge base for improving science teaching as inquiry

Interestingly, Suda, Piti and Thorn reflected several issues about how the 4 years course work prepared them knowledge base for organizing their classroom through scientific inquiry. These issues included instructional media, teaching strategies for scientific inquiry (e.g. cooperative learning, STS), nature of content, writing lesson plan, knowledge and skills about research, science teacher and primary school teacher characteristics, and teacher values. These could be interpreted through Suda, Piti and Thorn' s narrative as following.

Suda' s narrative

> I think that the course of my preservice teacher program should provide preservice teacher to know how to construct instructional media for different school level – primary and secondary school. So, I do not know how to construct or use instructional media for primary school students. Anyway, I can learn about it when I consult my school teacher advisors. And, I would like to prepare various kinds of activities for my lesson plan but I could not do because of limitation of my teaching experiences and knowledge of teaching strategies. However, I can find some solutions when I consult my school teacher advisors. …. The course about research provides me only meaning or feature of educational research, instead of research design and constructing research instrument. I enrolled to study the course of evaluation and assessment when I was the 3rd year. So, I forgot it when I was teaching practice in the 5th year; for example, how to do test blue print. … Teaching profession 1 – 3 supported me a lot when I practiced for school internship. This course provided me some perceptions of lesson plan writing, real situation of teaching, and different of school contexts and students. However, I think this course was not well prepared for me because I was the first cohort of the 5-year program of preservice teacher. …. The science courses that I studied from Faculty of science support me how to provide experiment and skills for doing experiment. With strong of science content, I could provide meaningful scientific explanation linking to each of student groups. …. I think I can remember the important things from the course about science teaching and learning even I passed it for long. It provided me how to analyze science content standard, long lesson plan, and writing lesson plan.

Piti's narrative

> I improve my understanding about science when I teach my class. I expected to learn more about pedagogy and science content. I supposed to know more teaching strategies and what teaching strategies are propriate for each science concept learning. I have more understand about what science content should be taught for Grade 6. And, what learning activities should be provided in those concepts and for those students. … I got some knowledge about research. However, I am not clear in research methodology. I knew that

research should be started from the research question. But, what should I do next when I get research problem?

Thorn's narrative

I learned many things during my 4 years of coursework before school internship. These included innovative teaching like "cooperative learning", "STS", and so on. I think that STS is difficult for me because I hard to find social issues to connect to scientific inquiry. I learned many styles of writing lesson plans. The courses of teacher profession 1, 2, and 3 suggested me to know students, schools, classroom management, teaching techniques, and scientific knowledge. I learned from my school teacher mentors (Ajarn Thong, Ajarn Suchat, and Ajarn Chalong). Ajarn Thong showed me how to become nice teacher. Ajarn Chalong showed me about science teaching techniques. …. And, Ajarn Suchart showed me about classroom management. Sometimes, even though Ajarn Suchart was asleep, the children still did not dare to talk.

4. Conclusion

This study reflected what and how three preservice science teachers learned, aware, and improve their knowledge and skills for their organizing science teaching as inquiring during their school internship. They not only learned universal science teaching as inquiry but also awareness of science teacher characteristics regarding on Thai value. They found their viable strategies for scientific inquiry based on student graders, school contexts, and nature of science concepts. The school internship with school teacher mentoring suggested them to undertake their own independent investigations and connect their findings with approaches for employing inquiry in their own classrooms (Hand & Peterson, 1995; Stofflett & Stoddart, 1994). Three preservice science teachers' narrative represented also how they improve their pedagogical content knowledge. These could be viewed when they mentioned what and how to find teaching techniques appropriated for different student graders, nature of science contents, school context, and teacher characteristics for primary and secondary schools.

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