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Mathematics Educators' Perspective on Pre-service Mathematics Teachers' Professional Competencies

Sirirat Chaona[1, 2], Maitree Inprasitha[1, 2], Narumon Changsri[1, 2] & Kiat Sangaroon[3]

[1] Mathematics Education Program, Faculty of Education, Khon Kaen University, Thailand

[2] Center of Excellence in Mathematics, CHE, Si Ayutthaya RD., Bangkok, Thailand

[3] Department of Mathematics, Faculty of Science, Khon Kaen University, Thailand

Correspondence: Maitree Inprasitha, Mathematics Education Program, Faculty of Education, Khon Kaen 40002, Thailand. E-mail: inprasitha_crme@kku.ac.th

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Abstract

This research was designed to study pre-service mathematics teachers' professional competencies to assist student learning by using Lesson Study and Open Approach innovations from mathematics educators' perspectives. A total of 35 mathematics educators have more than three years of experience not only in terms of utilizing the Lesson Study and Open Approach innovations but also in providing training to the pre-service mathematics teachers were selected. The researchers employed three data collection methods, namely document analysis, a survey using a questionnaire, and interviews. The obtained data from three sources was designed with the principle of triangulation. The findings of this research were presented under the three steps of the Thailand Lesson Study Model. In the first step, "Collaboratively Design Research Lesson Plan", pre-service teachers can create problem situations that associated with the students' real world, can analyze the context of the problem situations, can analyze keywords that initiate students' ideas, can anticipate students' ideas, and can prepare teaching materials to support students' ideas. This is followed by the second step as "Collaboratively Observe Research Lesson". The findings revealed that pre-service teachers can observe students' ideas when their students were solving mathematical problems, can notice students' difficulties in their learning, can give feedback using words that match with students' proficiency level, give students opportunities to show how to think and present their ideas, listen to and accept students' opinions, and taking notes on students' ideas or pieces of learning evidence. The findings of the final step namely "Collaboratively Reflect on Teaching Practice" showed that pre-service teachers could reflect the learning outcomes by correlating students' ideas with the instructions.

Keywords: mathematics educators, pre-service mathematics teacher, professional competencies

1. Introduction

One of the priority agendas from the 11 Southeast Asian Countries led by the Southeast Asian Minister Education Organization (SEAMEO) from 2015 to 2035 is to revitalize teacher education (Teachers' Council of Thailand, 2018). The emphasis on quality of education focuses on students' performance, including what students actually learn and how well they learn, has been taken into account. This is supported by Organization for Economic Cooperation and Development (OECD) (2012) who agreed that the learning standards should be emphasized and incorporated the 21st Century skills that contain both learning literacy and life skills as competencies in envisaging future challenges.

Mathematics is one of the enormously useful and captivating bodies of knowledge because mathematics can help the student in many critical areas of education that can solve the supreme problems we usually confront (Tsafe, Yusha'u, & Eya, 2014). This is supported by Thong (2017) who considered mathematics subject as the principal device in inspiring students' logical reasoning, critical and creative thinking, intangible or latitudinal thinking, problem-solving ability, and effective communication skills. In this line of reasoning, mathematics teachers need to establish dynamic and supportive qualities to mathematics teaching, consequently making mathematics teachers subsidize significantly to their accomplishment in teaching skill, as emphasized by Tsafe et al. (2014).

In the Thai context, Inprasitha has adapted and proposed two innovations, namely, Lesson Study and Open Approach, for changing a paradigm teaching practices of teachers and improving the teaching practices consecutively (Inprasitha 2004, 2009). The Open Approach emphasizes individual differences, especially

differences in each student's thinking, composed of four phases: (i) Posing open-ended problem; (ii) Students' self-learning; (iii) Whole class discussion and comparison, and (iv) Summarize through connecting students' mathematical ideas emerged in the classroom. The Lesson Study, besides, emphasizes on improving the collaborative working of teachers for improving and developing the Open Approach directly, consisted of three steps: (i) Collaboratively design research lesson (Plan); (ii) Collaboratively observe research lesson (Do), and (iii) Collaboratively reflect on teaching practice (See) (Inprasitha, 2011). Figure 1 illustrates the Thailand Lesson Study Model by incorporated Open Approach in the second step of the Lesson Study process (Inprasitha, 2011; 2014).

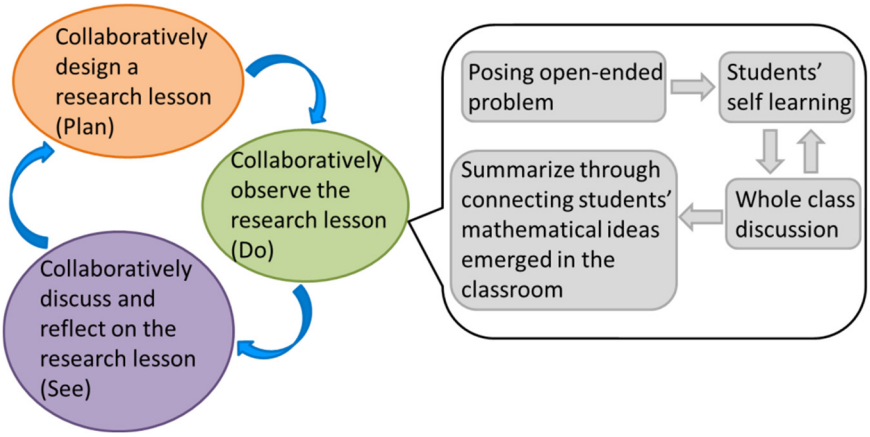

Figure 1. Thailand Lesson Study Model

In this context, the researchers would like to explore how the pre-service teachers' professional competencies could be developed while implementing the Thailand Lesson Study Model from the perspective of teacher educators. Therefore, Open Approach is a teaching approach and an aspect of Lesson Study, while Lesson Study is a tool to improve the teaching approach (Inprasitha, 2011). As a result, this research was aimed to investigate teacher educators' involvement in cultivating pre-service mathematics teachers' professional competencies, particularly in terms of helping students learning using the Thailand Lesson Study Model.

2. Method

A total of 35 mathematics educators who have more than three years of experiences in utilizing the Lesson Study and Open Approach innovations and providing training to the pre-service mathematics teachers were purposively selected as the target group of this research. The purposive sampling technique was found suitable for this research because they have participated in several teacher's professional development training conducted by the Centre for Research in Mathematics Education, Faculty of Education, Khon Kaen University. The target group consisted of mathematics educators who are university academic staff or postgraduate students from the Mathematics Education Program of the research university, located in Khon Kaen province, Thailand.

A multi-cases study using survey research design was employed because it can bend three methods into justified the research approach. Therefore, the researchers employed three modes of data collection, namely document analysis, a survey using a questionnaire, and interviews. The attained data from three sources were intended for the principle of triangulation. The process of validation using the multi-method research approach is an iterative process that involves organizing and interpreting data from one source into a tentative explanatory framework and testing this framework against data developed from a second source. Confirmation strengthens the explanatory framework and can be further tested using data from a third source. The result was a strong confirmation that these professional competencies were seen as essential of pre-service mathematics teachers (Gay, Mills, & Airasian, 2011).

The researchers started their investigation by employing a survey questionnaire to collect quantitative data from the mathematics educators related to pre-service mathematics teachers' professional competencies specifically in assisting students in learning. The survey questionnaire was used to collect information on mathematics educators' perceptions about pre-service mathematics teachers' professional competencies while participating in the three steps of the Lesson Study process, namely, Plan, Do, and See. The survey questionnaire instrument was administered in the Thai language to ensure that the mathematics educators were clearly understood the items.

The questionnaire consisted of 23 items and three sections. To measure the mathematics educators' responses towards pre-service mathematics teachers' professional competencies, a five-point Likert scale was used. Section A of the questionnaire comprised of four items that intended to gather information pertaining to pre-service mathematics teachers' professional competencies while collaboratively designing the research plans. The professional competencies of Step Plan include their abilities in writing a statement using keywords, preparing media to make the command and keyword clear, analyzing the context of problem situations, and making statements from teachers' ideas.

The researchers specifically designed section B to gauge information of the pre-service mathematics teachers' professional competencies while they were collaboratively observing the research lesson. The professional competencies of Step Do encompass their abilities in presenting orders, explaining the command, realizing what have learned before, asking questions that were not planned, connecting students' ideas, observing students' ideas, noticing their own problems based on evidence, witnessing students take actions as what have planned, designing problem situations, recording students' ideas, comparing the similarities of students' ideas, sequencing students' ideas, concluding students' ideas, not guessing students' ideas, and not evaluating students' ideas. Section B was comprised of 16 items.

The researchers precisely planned section C to measure information of the pre-service mathematics teachers' professional competencies while collaboratively reflecting on teaching practice. The professional competencies of Step See comprehend their abilities in reflecting on results by correlating students' ideas with instructions, criticizing the teacher's teaching method, and influencing or directing what the teacher needs to improve.

This is followed by interviewing 35 random mathematics educators associated with Lesson Study and Open Approach context. The focus of the interview was not on a routine basis but rather on the contingent nature of the professional practice. A series of interview questions to the 35 mathematics educators had guided them to describe the incident, reflect on the action at the time of utilizing the Thailand Lesson Study Model, explain why the incident was found significance to them, and finally describe how this incident had affected their practice. Therefore, researchers derived primarily those statements that describing teachers' knowledge base from the memorable incident interviews to analyze and triangulate with the school reports that related to teachers' competence. This was used as confirmation evidence. The examples in the description were taken from the memorable incident interviews and provided context to the action statements. Real examples of practice illustrate the integrated nature of professional activities that draw on the skills, knowledge, and other underpinning attributes of practice; consequently, they often provide evidence of any contributing factors to competent performance.

Firstly, researchers collected data from the pre-service mathematics teacher while they were practicing the Thailand Lesson Study Model using various sources such as research lesson plans, audio recording, and video recording. Secondly, researchers interviewed the pre-service mathematics teachers after they finished a complete cycle of Lesson Study process. Finally, researchers revised the reflection notes as important documents to analyze and triangulate with the two initial sources of data. The research procedure consisted of three phases. The pre-service mathematics teachers worked collaboratively to develop lesson plans by incorporating an Open approach in the first phase. This is followed by the second phase; whereby pre-service mathematics teachers observed the teaching by focusing on student learning assistance. At the final stage, the pre-service teachers discussed and reflected the teaching results, examined the observation-derived results, and attempted to improve the research lesson.

3. Findings

The findings of this research are presented in parallel to the research aim stated above. The initial findings are descriptive findings of pre-service mathematics teachers' professional competencies and their ranking and the three steps of the Lesson Study process. Finally, findings from mathematics educators' opinions about pre-service mathematics teachers specifically while they were participating in the three steps of Lesson Study. Table 1 shows the descriptive findings of pre-service mathematics teachers' professional competencies.

3.1 Survey Questionnaire Findings

Table 1. Descriptive findings of pre-service mathematics teachers' professional competencies

Items	Mean Score	*SD*	Interpret	Rank
Collaboratively design research plan (Plan)				
Write a statement by using keyword clearly.	4.69	0.58	Strongly agree	4

Prepare media to make the command and keyword clear.	4.71	0.52	Strongly agree	3
Analyze the "context" of the problem situation and analyze the "keywords" that will condition the students' approach to ideas.	4.74	0.66	Strongly agree	2
Make a statement or keyword from the teacher's ideas.	2.71	1.54	Neutral	13
Collaboratively observe research plan (Do)				
Present orders with no explanation or direct inquiries.	4.17	1.07	Agree	11
Explain or ask about the command.	2.66	1.41	Neutral	15
If there is a review, try to realize for yourself what the “How to” you have learned before.	4.29	0.99	Strongly agree	10
Review by asking for knowledge or techniques directly.	2.26	1.29	Disagree	15
Ask questions that were not planned in advance.	2.11	1.39	Disagree	16
Connect students' ideas as they arise.	4.66	0.59	Strongly agree	5
Observe student ideas as students solve problems.	4.86	0.43	Strongly agree	1
Notice if the student is attached to the situation and has their own problems based on the evidence, including there is a hassle, there are obstacles, curiosity, etc.	4.74	0.56	Strongly agree	2
Notice if students plan problem-solving and take action as planned.	4.54	0.66	Strongly agree	8
Use the conceptual projections that were created when designing problem situations as a framework for observing plans and solving problems.	4.69	0.53	Strongly agree	4
Record student ideas arising during planning and problem solving according to plan.	4.71	0.52	Strongly agree	3
Discuss and compare the similarities of the student's ideas.	4.54	0.61	Strongly agree	8
The sequence of students' ideas is presented from the most imperfect to the most complete, with students' ideas being justified.	4.49	0.66	Strongly agree	9
Conclude together with students to make them realize ideas that arise and become "How to learn" for solving problems in the future.	4.60	0.65	Strongly agree	7
Try not to get students to guess what teaches today or what they want.	3.83	1.10	Agree	12
Evaluated by right and wrong judgment.	1.34	0.97	Strongly disagree	19
Collaboratively reflect on teaching practice (See)				
Reflect on results by correlating students' ideas with instructions.	4.63	0.55	Strongly agree	6
Reflect the results by criticizing the teachers.	1.43	1.07	Strongly disagree	18
Influence, direct what the teacher wants.	1.63	1.09	Strongly disagree	17

Table 1 shows the mean scores and standard deviations of Step 1 (Plan) ranged from 2.71 to 4.74. Considering the first two orders, found that the highest mean score was “analyze the "context" of the problem situation and analyze the "keywords" that will condition the students' approach to ideas” ($\bar{x}$ = 4.74, SD = 0.66). The second order was “prepare media to make the command and keyword clear” ($\bar{x}$ = 4.71, SD = 0.52). Next, the mean scores and standard deviations of Step 2 (Do) ranged from 1.34 to 4.86. Considering the first two orders, found that the highest mean score was “observe student ideas as students solve problems” ($\bar{x}$ = 4.86, SD = 0.43). The second order was “notice if the student is attached to the situation and has their own problems based on the evidence, including there is a hassle, there are obstacles, curiosity, etc.” ($\bar{x}$ = 4.74, SD = 0.56). Finally, the mean scores and standard deviations of Step 3 (See) ranged from 1.43 to 4.63. The highest mean score was “reflect on results by correlating students' ideas with instructions” ($\bar{x}$ = 4.63, SD = 0.55).

3.2 Interview Findings

The interview findings with mathematics educators regarding pre-service mathematics teachers’ professional competencies are demonstrated in three steps of the Lesson Study, namely Plan, Do, and See.

3.2.1 Step 1: Plan

The interview findings revealed pre-service mathematics teachers could create problem situations related to the students' real world and analyze "context" from problem situations. Besides, they can analyze the keywords that cultivating students' ideas in solving mathematical problems. Furthermore, they can anticipate students' ideas and prepare learning materials to support their students' points of view.

3.2.2 Step 2: Do

The interview findings indicated that pre-service mathematics teachers possess the capabilities in observing students' ideas while students solve mathematical problems. Besides, they can listen to students actively and quietly and be patient to listen while students are having difficulties. On top of that, they can give feedback using words that match with students' proficiency level. Moreover, they can provide students with opportunities to show how to think and present their ideas. Lastly, they can listen and accept students' opinions and taking notes on students' ideas or pieces of learning evidence.

3.2.3 Step 3: See

The interview findings of the final step showed that pre-service teachers could reflect the learning outcomes by correlating students' ideas with the instructions.

4. Discussion and Conclusion

The overview of this research findings implies a piece of substantial evidence about the significance of using Lesson Study and Open Approach to enhance pre-service mathematics teachers' professional competencies to assist their student learning. The findings showed that pre-service mathematics teachers can observe their students' ideas effectively. Moreover, this finding is corresponding to Inprasitha's (2016) proposed ideas. Inprasitha mentioned that observing students' ideas is one of the critical skills that mathematics teachers must possess. Therefore, Inprasitha (2016) suggested the observation skills should be integrated into the course of professional teacher training and the curriculum of higher education institutions. Besides, Manmai, Inprasitha, Changsri, and Pattanajak (2020) noticed the importance of mathematics teachers' abilities in observing students' ideas as a critical component of teaching expertise.

Moreover, qualitative findings revealed that pre-service mathematics teachers can anticipate students' ideas and prepare learning materials to support their students' views. This is fulfilling an essential aspect of implementing Open Approach and Lesson Study innovations, mainly when mathematics teachers are dealing with a complex problem situation, as mentioned by van Es and Sherin (2010). Besides, Takahashi and Yoshida (2004) highlighted the context of Lesson Study which had been used by Japanese teachers and educators for professional development nationwide. In conclusion, it is paramount that mathematics teachers, either pre-service or in-service, must possess sufficient professional competencies to associate the relevant learning contents to the requirement of the 21st Century.

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