CHAPTER 3

Research Methodology

The research study entitled "A Model of Developing Mentor Teachers' Competencies to Enhance Mathematics Learning Provision in the 21st Century" was conducted following the research and development process of four phases as follows:

Phase 1: Exploration of conditions of mathematics learning and teaching management, current mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century

Phase 2: Development of model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

Phase 3: Trial of model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

Phase 4: Investigation of results of the implementation of model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

Methodology of this research study is presented in phases to explain the relationship of its purposes, methodology, research sampling, and instruments for data collection, development and validation of instruments, data collection, and data analysis. Details of the research methodology in each phase are illustrated

3.1 Phase 1: Exploration of conditions of mathematics learning and teaching management, current mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century

In this phase of study, documents, textbooks, and research studies related to conventional mathematics learning and teaching management, mathematics learning and teaching management in the 21st century, and the concept of a Professional Learning Community (PLC) were examined in order to determine the indicators for mentor teachers' competencies promoting mathematics learning and teaching management in the 21st century. The sample of the study consisted of mentor teachers and mathematics student-teachers. Instruments used for data collection included a 5-level rating scale questionnaire inquiring about the present conditions of learning and teaching management, knowledge and understanding of mentor teachers about mathematics learning and teaching management in the 21st century, the supervision that promotes learning and teaching management in the 21st century, and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century. In addition to administering the questionnaire, interviews about conditions and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century were also carried out. The research study in this phase was conducted using the following three stages.

Stage 1: Investigate and synthesize concepts and theories from documents and research studies related to mathematics learning and teaching management in the 21st century and Professional Learning Communities (PLC).

Stage 2: Develop research instruments and determine competency indicators for mentor teachers promoting mathematics learning and teaching management in the 21st century.

Stage 3: Explore the present conditions and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century.

The research methodology is presented as follows.

3.1.1 Research objectives

At this stage, the research was conducted following one main research objective and two subordinate objectives.

Main objective: To examine the conditions of mathematics learning and teaching management, current mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century

Subordinate objectives:

1) To investigate and synthesize literature and research studies related to mathematics learning and teaching management in the 21st century and student-teachers supervision promoting mathematics learning and teaching management in the 21st century

2) To analyze baseline data of mathematics learning and teaching management, mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century

3.1.2 Research methods

1) Investigate and synthesize literature and research studies related to mathematics learning and teaching management in the 21st century and Professional Learning Communities (PLC) in order to determine competency indicators for mentor teachers promoting mathematics learning and teaching management in the 21st century

2) Construct and develop research instruments based on the above-mentioned indicators to examine conditions of mathematics learning and teaching management, present mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century

3) Explore mentor teachers' opinions about the conditions of mathematics learning and teaching management, present mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century according to the indicators with regard to knowledge, skills, and attitudes, respectively

4) Interview the mentor teachers about the conditions of mathematics learning and teaching management, present mentor teachers' supervision and their needs for

competencies development promoting mathematics learning and teaching management in the 21st century

3.1.3 Research sample

In the study of the conditions of mathematics learning and teaching management, present mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century, the research sample consisted of a group of mentor teachers supervising student-teachers majoring in mathematics from Rajabhat universities of the upper northern cluster. Quota sampling technique (Nonglak Wiratchai, 2000: 148) was employed for finding these representatives which constituted 60 percent of the population (Narong Poplueksanant, 2008). As the population was between 300-400, the sample size of this study was 214, accordingly.

Table 3.1 Population and Sample

University	Population	Sample
Lampang Rajabhat	82	50
Chiang Mai Rajabhat	85	51
Chiang Rai Rajabhat	86	51
Uttaradit Rajabhat	108	62
Total	**361**	**214**

3.1.4 Instruments for data collection

1) A form for literature synthesis

2) A questionnaire exploring mentor teachers' opinions about conditions of mathematics learning and teaching management, mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century

3) Interview schedule inquiring about conditions and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century

3.1.5 Development and validation of research instruments

1) Review concepts of mathematics learning and teaching management in the 21st century and Professional Learning Communities (PLC) in order to synthesize and determine competency indicators for mentor teachers promoting mathematics learning and teaching management in the 21st century. After reviewing and synthesizing 16 pieces of related literature, 62 competency indicators for mentor teachers in learning and teaching management, and their supervision promoting mathematics learning and teaching management in the 21st century were determined.

2) Develop instruments to examine the conditions of mathematics learning and teaching management, mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century. Through the development of the instruments, the 62 competency indicators were then broken into three features: 21 for knowledge, 26 for skills, and 15 for attitudes, respectively.

3) Present all the instruments to five experts in order to examine the content validity by examining the consistency of definitions of terms and variables through the study of mathematics learning and teaching management, mentor teachers' supervision and mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century. The experts checked the content validity of the two instruments ascertaining that the Index of Congruence (IOC) of each item was between 0.6 and 1.0. From this, items with IOCs of 0.8 or higher were chosen and the wording was revised as suggested by the experts. After the revision, 55 competency indicators for mentor teachers promoting mathematics learning and teaching management in the 21st century were finalized: 19 for knowledge, 23 for skills, and 13 for attitudes, respectively.

4) Try out the questionnaire with the experimental group of 30 mentor teachers supervising student-teachers majoring in mathematics to examine its reliability using Cronbach's Alpha Test. The results found that the reliability of this research instrument was 0.89. The questionnaire was then adjusted as suggested by the experts before its use in the study.

3.1.6 Data collection

1) An official letter from the Faculty of Education, Chiang Mai University dated 4 June 2015 and a questionnaire were mailed to each of the 361 mentor teachers requesting them to answer and send it back to the researcher by 10 July 2015.

2) Out of 250 questionnaires returned to the researcher, 214 were completely answered and used in data analysis.

3) As for the interviews, appointments with ten purposively selected interviewees were made in advance, and the researcher conducted the interviews from 1 to 30 August 2015.

4) The data from the questionnaires and the interviews were analyzed and conclusions were made about the conditions of mathematics learning and teaching management, mentor teachers' supervision and their needs for competencies development promoting mathematics learning and teaching management in the 21st century. The information obtained was used as a guideline for developing model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century.

3.1.7 Data analysis

1) Descriptive statistics: percentage, mean, and standard deviation were used for the data analysis.

Formulae (Kalaya Wanichbancha, 2007):

(1) Percentage

$$\text{Percentage} = \frac{\text{Given quantity}}{\text{Total amount}} \times 100$$

(2) Mean (Frequency Distribution)

$$\overline{X} = \frac{\sum fx}{\sum f}$$

(3) Standard deviation (Frequency Distribution)

$$SD = \sqrt{\frac{\sum f(x-\bar{x})^2}{\sum f - 1}}$$

Where $\overline{X}$ = mean of the sample

SD = the standard of deviation of the sample

f = number of those who answered the questionnaire

X = values of in the data set as stated below

5 means the opinions of mentor teachers toward an item about the present conditions of mathematics learning and teaching management, mentor teachers' supervision and needs for competencies development is at the highest level

4 means the opinions of mentor teachers toward an item about the present conditions of mathematics learning and teaching management, mentor teachers' supervision and needs for competencies development is at a high level

3 means the opinions of mentor teachers toward an item about the present conditions of mathematics learning and teaching management, mentor teachers' supervision and needs for competencies development is at a moderate level

2 means the opinions of mentor teachers toward an item about the present conditions of mathematics learning and teaching management, mentor teachers' supervision and needs for competencies development is at a low level

1 means the opinions of mentor teachers toward an item about the present conditions of mathematics learning and teaching management, mentor teachers' supervision and needs for competencies development is at the lowest level

2) Data from the interviews were analyzed using content analysis technique (Wandee Sutthinarakorn, 2013).

Criteria for data interpretation

Interpretation of the opinions of mentor teachers toward each item in the questionnaire about the present conditions of mathematics learning and teaching management, mentor teachers' supervision and their needs for competencies development promoting mathematics learning and teaching management in the 21st century were conducted by benchmarking against the criteria proposed by Best (John W. Best, 1970) as follows.

An average between 4.51-5.00 means the opinions of mentor teachers are at the highest level

An average between 3.51-4.50 means the opinions of mentor teachers are at a high level

An average between 2.51-3.50 means the opinions of mentor teachers are at a moderate level

An average between 1.51-2.50 means the opinions of mentor teachers are at a low level

An average between 1.00-1.50 means the opinions of mentor teachers are at the lowest level

3.2 Phase 2: Development of model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

In this phase, the researcher designed and developed model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century using the information from Stage 1 and the synthesis of human resource development, teacher development, theories of motivation, theories of adult learning, theories of counseling, and teaching supervision and techniques of coaching and mentoring. The researcher drafted a model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century and then used focus group discussion techniques to validate the drafting. After that, adjustments were made according to suggestions from the experts of the focus group. Furthermore, a handbook for the use of the model competencies development was then developed. Five experts examined the handbook's correctness and usability, and they then evaluated the effectiveness of the model development based on standards in four areas: 1) feasibility, 2) suitability, 3) correctness and sufficiency, and 4) usability, prior to implementation, which followed these six steps:

Step 1 A model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century was drafted.

Step 2 Correctness and suitability of the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century was examined.

Step 3 A handbooks for the use of the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century and a scale for evaluating mentor teachers were written and their validity and correctness examined.

Step 4 Focus group discussion techniques were used to validate and finalize the draft model competencies development.

Step 5 Adjustments as suggested by the experts were made.

Step 6 Effectiveness of the model development for mentor teachers promoting mathematics learning and teaching management in the 21st century based on the standards in four areas as previously mentioned was evaluated.

3.2.1 Objectives

At this stage, the research was conducted following one main research objective and three subordinate objectives.

Main objective: To develop model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

Subordinate objectives:

1) To determine the components of model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

2) To create and develop model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

3) To evaluate the effectiveness of the model development based on the standards in four areas

3.2.2 Methods

1) Investigate and synthesize literature and research studies related to model development, human resource development, teacher development, theories of motivation, theories of adult learning, theories of counseling, teaching supervision, and techniques of coaching and mentoring to determine the components of the model development.

2) Apply the results from Stage 1 to develop the model development by considering the indicators with the lowest average scores regarding the present conditions of mathematics learning and teaching management which, at the same time, had the highest average scores in terms of mentor teachers' needs for competencies development promoting mathematics learning and teaching management in the 21st century. The results regarding the indicator related to knowledge revealed that "the mentor teachers enjoy the knowledge

of creative and innovative thinking" which carried a moderate level average score ($\overline{X}$=3.40, SD=0.79), and the needs for development was at a high level ($\overline{X}$=4.25, SD=0.82); the indicator regarding skills showed that "the mentor teachers possess the skills of facilitating the Teach Less, Learn More learning activities in the classroom" which had a moderate level average score ($\overline{X}$=3.39, SD=0.74) and the needs for development was at a high level ($\overline{X}$=4.14, SD=0.93), and it also showed that "the mentor teachers possess the creative and innovative thinking skills" which also had a moderate level average score ($\overline{X}$=3.41, SD=0.75) and the needs for development was at a high level ($\overline{X}$=4.16, SD=0.93); as for the indicators regarding attitudes, all were at a high level. These findings were used in developing model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century, making the development process focus mainly on providing the knowledge and skills mentioned above.

3) Draft a model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century.

4) Present the draft to the experts in the focus group discussion to validate the draft model development, and then adjust it as suggested by the experts.

5) Evaluate the effectiveness of the model development according to the standards in four areas as previously mentioned.

3.2.3 Sampling

The sample breaks into 2 groups:

1) A group of six experts who scrutinized and finalized the draft model competencies development. This team of experts consisted of those who possessed certain areas of expertise and experiences as presented below.

(1) An expert in the area of human resource development who was a university professor with experience in teacher development or who conducted research studies on teacher development

(2) An expert in the area of mathematics learning and teaching management who was a university professor with experience in mathematics learning and teaching management and student-teachers supervision

(3) An expert in the area of field work experience of student teaching who was a university professor with experience in student-teacher supervision

(4) Two experts who were school administrators whose schools used a problem-based approach in mathematics learning and teaching management, and who had experience collaborating with mentor teachers in supervising student-teachers at school

(5) An expert who was a mentor teacher with experience in supervising student-teachers majoring in mathematics

2) A group of 12 experts who examined the effectiveness of the model competencies development. This team of experts consisted of those who possessed certain areas of expertise and experiences as presented below

(1) Two experts in the area of human resource development who were university professors with experience in teacher development or who conducted research studies on teacher development

(2) Two experts in the area of mathematics learning and teaching management who was a university professor with a minimum of 5 years of experience in mathematics learning and teaching management as well as student-teacher supervision

(3) An expert in the area of educational measurement and evaluation who was a university professor with a minimum of 5 years of experience in educational measurement and evaluation

(4) Two experts in the area of field work experience of student-teaching who was a university professor with experience in student-teacher supervision or those in charge of student-teaching experience at the university

(5) An expert who was a mentor teacher with a minimum of 5 years of experience in supervising student-teachers majoring in mathematics

(6) Two experts who were school administrators whose schools had offered an internship to student-teachers majoring in mathematics for a minimum of 5 years, and the schools implemented a teaching approach focusing on developing students' thinking and problem-solving skills

(7) Two experts who were mentor teachers in schools that offered an internship to student-teachers majoring in mathematics for a minimum of 5 years

3.2.4 Instruments for data collection

1) Focus group discussion form

2) Scale for the effectiveness of the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century according to the standards in four areas: 1) feasibility, 2) suitability, 3) correctness and sufficiency, and 4) usability

3.2.5 Development and validation of instruments

1) Review concepts, theories and principles of focus group discussion and data recording, create a form with specification tables connecting important points suggested by the experts, and evaluate the effectiveness of the model competencies development.

2) Construct the two instruments.

3) Present the two instruments to the experts to validate the correctness and suitability and the content validity, as well as the clarity of the language. As for the scale for the effectiveness of the model competencies development, calculate the Index of Congruence (IOC) of opinions from the three experts as presented in details below.

(1) Focus group discussion form was a 2-way table displaying topics of the focus group discussion and suggestions from the experts no. 1-6, and presenting strengths and weaknesses that need improvement regarding the model competencies development. The IOC of this instrument was 1.

(2) Scale for the effectiveness of the model competencies development consisted of 36 items; 8 were in the standard of feasibility, 8 were in the standard of suitability, 10 in the standard of correctness and sufficiency, and 10 in the standard of usability respectively. The IOC of all items was 0.80 and higher.

3.2.6 Data collection

1) Conduct a focus group discussion to scrutinize the draft model competencies development by sending an invitation letter from the Faculty of Education, Chiang Mai University dated 11 November 2015 to the experts requesting them to join the focus group discussion. Attached in the letter were details of the draft model competencies development and its handbook.

2) The six experts probed into the draft model competencies development on 28 November 2015 in a conference room at Applied Sciences Center of the Faculty of Science, Lampang Rajabhat University.

3) Analyze and make conclusions about the results of the focus group discussion. In consequence, a model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century contained principles, concepts, purposes, development processes, roles of people, who were responsible, and measurement and evaluation. There were two major stages in the model competencies development: Stage 1 Get Ready, which consisted of 3 steps: 1) new motivation, 2) new knowledge, and 3) new skills; Stage 2 Take Action, which also broke into 3 steps: 4) collaboration, 5) action, and 6) reflection.

4) Adjust the model competencies development as suggested by the focus group discussion of the mentor teachers.

5) Present the improved draft to another team of experts by sending an official letter from the Faculty of Education, Chiang Mai University dated 1 March 2016 to ask them to examine the draft and give their opinions with regard to the four standards of feasibility, suitability, correctness and sufficiency, and usability.

6) Finally, the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century with the effectiveness at the highest level in all four areas of standards was finalized.

3.2.7 Data analysis

1) Descriptive statistics: mean and standard deviation were used for data analysis.

Formulae for calculation:

(1) Mean (Frequency Distribution)

$$\overline{X} = \frac{\sum fx}{\sum f}$$

(2) Standard deviation (Frequency Distribution)

$$SD = \sqrt{\frac{\sum f(x-\bar{x})^2}{\sum f - 1}}$$

Where $\overline{X}$ = means of the sample

SD = the standard of deviation of the sample

f = number of those who answered the questionnaire

X = values of in the data set as stated below

5 means the opinions of the experts toward an item with regard to the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability are at the highest level.

4 means the opinions of the experts toward an item with regard to the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability are at a high level.

3 means the opinions of the experts toward an item with regard to the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability are at a moderate level.

2 means the opinions of the experts toward an item with regard to the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability are at a low level.

1 means the opinions of the experts toward an item with regard to the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability are at the lowest level.

2) Data from the focus group discussion was analyzed using the content analysis technique (Wandee Sutthinarakorn, 2013).

Criteria for data interpretation

Interpretation of the opinions of the experts toward all items in the scale of the effectiveness of the model competencies development using average scores were conducted by benchmarking against the criteria proposed by Best (John W. Best, 1970) as follows.

An average between 4.51-5.00 means the opinions of the experts are at the highest level.

An average between 3.51-4.50 means the opinions of the experts are at a high level.

An average between 2.51-3.50	means the opinions of the experts are at a moderate level.
An average between 1.51-2.50	means the opinions of the experts are at a low level.
An average between 1.00-1.50	means the opinions of the experts are at the lowest level.

3.3 Stage 3 Trial of the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

At this stage, the researcher attempted the model competencies development from Stage 2 with groups of mentor teachers and student-teachers to explore the problems and obstacles regarding the implementation of model competencies development, had the mentor teachers evaluate the effectiveness of the model competencies development, and then used the results from the trial to improve the model competencies development. The details of the trial are presented as follows.

Stage 1 Get Ready

During this stage, the mentor teachers, student-teachers, and university supervisors were prepared for the development through participatory workshops to raise their awareness, enhance their willingness and commitment to their responsibility as mentor teachers and university supervisors, and to provide them with additional knowledge about collaboration among mentor teachers and university advisors to develop student-teachers, as well as knowledge about mathematics learning and teaching management in the 21st century based on thinking-provoking and problem-solving approach in which teachers are facilitators. In addition, mentor teachers were encouraged to collaborate with student-teachers in mathematics learning and teaching management in the 21st century through a procedure of 3 steps as illustrated below.

Step 1: New Motivation

A school visit program for mentor teachers was introduced in order to motivate mentor teachers to develop themselves and student-teachers in terms of mathematics learning and teaching management in the 21st century. Some of the school chosen for these visits were schools where there were experienced mentor teachers.

Step 2: New Knowledge

A workshop through which mentor teachers learned about mathematics learning and teaching management in the 21st century and Professional Learning Communities (PLC) where they can learn and collaborate with each other was conducted. The activities in the workshop included mathematics problem-solving and video-watching.

Step 3: New Skills

A workshop was carried out through which mentor teachers were able to enhance student-teacher mentoring skills, and learn how to write lesson plans and classroom management focusing on helping students to think and solve problems on their own. After that, some mentor teachers conducted a lesson-planning session with student-teachers and picked out student-teachers to use the lesson plans, whereas the other mentor teachers observed the student-teaching activities. All parties exchanged their feedback on the learning and teaching activities managed by the student-teachers.

Stage 2 Take Action

During this stage, the knowledge and skills gained from Stage 1 were put in practice in the schools where mentor teachers helped student-teachers with lesson plans, organized classroom visits and reflected on the learning and teaching activities for improvements using the CAR cycle as presented below.

Step 4: Collaboration: C

Mentor teachers and student-teachers did collaborative activities in which they wrote lesson plans based on mathematics learning and teaching management in the 21st century focusing on a thought-provoking and problem-solving approach.

Step 5: Action: A

Student-teachers learned from working with mentor teachers in writing lesson plans that focused on a thought-provoking and problem-solving approach and from classroom visits of mentor teachers and university supervisors.

Step 6: Reflection: R

Student-teachers, together with mentor teachers and university supervisors reflected on the learning and teaching activities.

3.3.1 Objectives

During this stage of the study, research activities were conducted for the following purposes.

Main objective: To develop model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

Subordinate objectives:

1) To try out the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

2) To evaluate the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century based on the standards in four areas as previously mentioned

3.3.2 Methods

1) The model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century developed in Phase 2 was tried out with 6 mentor teachers in 5 schools. Prior to this, a letter from the Faculty of Education, Chiang Mai University was sent to the schools requesting cooperation in the data collection.

2) The model competencies development was carried out in two stages. In Stage 1 Get Ready, a 3-day participatory workshop was organized for mentor teachers to prepare them for the development. In Stage 2 Take Action, the mentor teachers applied the knowledge and skills gained from the workshops to their real learning and teaching management in collaboration with student-teachers at their schools through a period of two months as further described below.

(1) An orientation meeting was called for the mentor teachers who were participating in the competencies development program.

(2) A competencies development process for mentor teachers promoting mathematics learning and teaching management in the 21st century took place.

3) Data of the model competencies development evaluation by the six mentor teachers according to the standards in four areas were collected. Interviews about problems and obstacles in using the model competencies development with these mentor teachers were also carried out.

4) Results of the trial of model competencies development were analyzed and summarized.

5) Adjustments were done as suggested by the participants in the trial of model competencies development.

3.3.3 Sampling

The sample of the study were six mentor teachers who volunteered to participate in the competencies development program for mentor teachers promoting mathematics learning and teaching management in the 21st century.

3.3.4 Instruments for data collection

1) A scale for appraising the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century according the standards in four areas: 1) feasibility, 2) suitability, 3) correctness and sufficiency, and 4) usability

2) An interview schedule

3.3.5 Development and validation of instruments

1) A scale for appraising the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century according the standards in four areas: feasibility, suitability, correctness and sufficiency, and usability developed in Phase 2 was employed by the participants to appraise the model competencies development package.

2) An interview schedule was devised and its construct validity and language accuracy were examined. The IOC of the experts' opinions was 1.00. The interview schedule was in a table form for recording answers to interview questions, strengths and areas that need improvements according to each interviewee's opinion.

3.3.6 Data collection

1) The model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century was tried out with a sample of mentor teachers. Prior to this, official letters from the Faculty of Education, Chiang Mai University dated 1 December 2015 was sent to the schools in the service areas of Lampang Rajabhat University requesting cooperation in the data collection.

2) Six volunteer mentor teachers from five schools: Ban Pong Sanook School, Ban Thok Hua Chang School, Ban Fon Community School, Lampang Provincial Sport School and Ban Kad Mek School were selected.

3) The model competencies development was tried out. In Stage 1 Get Ready, a 3-day participatory workshop was organized on 21-23 December 2015, and in Stage 2 Take Action was conducted through a period of two months from January to March in 2016.

4) The model competencies development appraisal by the mentor teachers according to the standards in four areas of feasibility, suitability, correctness and sufficiency, and usability were then carried out.

5) The participant mentor teachers were interviewed.

3.3.7 Data analysis

1) Descriptive statistics: mean and standard deviation were used for the data analysis.

Formulae for calculation:

(1) Mean (Frequency Distribution)

$$\overline{X} = \frac{\sum fx}{\sum f}$$

(2) Standard deviation (Frequency Distribution)

$$SD = \sqrt{\frac{\sum f\left(x-\bar{x}\right)^2}{\sum f - 1}}$$

Where $\overline{X}$ = means of the sample

SD = the standard of deviation of the sample

f = number of those who answered the questionnaire

X = values of in the data set as stated below

5 means the opinions of mentor teachers toward an item about the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability is at the highest level.

4 means the opinions of mentor teachers toward an item about the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability is at a high level.

3 means the opinions of mentor teachers toward an item about the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability is at a moderate level.

2 means the opinions of mentor teachers toward an item about the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability is at a low level.

1 means the opinions of mentor teachers toward an item about the effectiveness of the model competencies development according to the standards of feasibility, suitability, correctness and sufficiency and usability is at the lowest level.

2) Data from the focus group discussion were analyzed using the content analysis technique (Wandee Sutthinarakorn, 2013).

Criteria for data interpretation

Interpretation of the opinions of the mentor teachers who appraised the effectiveness of the model competencies development using average scores were conducted by benchmarking against the criteria proposed by Best (John W. Best, 1970) as follows.

An average between 4.51-5.00 means the opinions of the mentor teachers are at the highest level.

An average between 3.51-4.50 means the opinions of the mentor teachers are at a high level.

An average between 2.51-3.50 means the opinions of the mentor teachers are at a moderate level.

An average between 1.51-2.50 means the opinions of the mentor teachers are at a low level.

An average between 1.00-1.50 means the opinions of the mentor teachers are at the lowest level.

3.4 Phase 4 Investigation of the results of the implementation of the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century

In this phase, results of the implementation of the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century were investigated. In doing so, the model competencies development of which the effectiveness

was examined by the experts and which was improved after the experiment in schools was implemented through the three steps as follows.

Step 1 The researcher submitted the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century to the Department of Mathematics, Lampang Rajabhat University to be used in the mentor teachers' competencies development.

Step 2 Department of Mathematics, Lampang Rajabhat University carried out the model competencies development program following its handbook in two stages; that is, Stage 1 Get Ready and Stage 2 Take Action. The mentor teachers' competencies in terms of knowledge, skills and attitudes were evaluated before and after the development program. In addition to that, performance follow-up assessments were also conducted through a period of two months.

Step 3 The mentor teachers were interviewed so as to examine their satisfaction about the use of model competencies development and results after the development. Also, the satisfaction of the student-teachers about the mentor teachers' supervision was explored through their notes about the mentoring activities.

3.4.1 Objectives

At this stage the research was conducted following a main research objective and three subordinate objectives.

Main objective: To investigate the results of the implementation of the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century.

Subordinate objectives:

1) To evaluate the mentor teachers' competencies in three aspects: knowledge, skills, and attitudes.

2) To examine the mentor teachers' satisfaction about the use of the model competencies development.

3) To explore student-teacher satisfaction with regard to the mentor teachers' supervision**.**

3.4.2 Research Methods

The researcher conducted the study following the process of the model of developing mentor teachers' competencies to enhance mathematics learning provision in the 21st century as presented below.

1) An official letter from the Faculty of Education, Chiang Mai University dated 20 February 2016 was sent to Lampang Rajabhat University requesting cooperation in implementing the model competencies development.

2) Department of Mathematics of Lampang Rajabhat University carried out the model competencies development program following its handbook in two stages; that is, Stage 1 Get Ready from 31 March to 2 April 2016, and in Stage 2 Take Action, the mentor teachers implemented the model competencies development in their respective schools through a period of two months from 16 May to 16 July 2016. The details of the process are presented as follows.

(1) An orientation meeting was called for the mentor teachers who were participating in the competencies development program.

(2) A competencies development process for mentor teachers promoting mathematics learning and teaching management in the 21st century took place from 31 March 2016 to 2 April 2016 according to the following steps.

(2.1) The mentor teachers appraised their own competencies in the aspects of knowledge, skills and attitudes before the program.

(2.2) The mentor teachers followed the process in Get Ready stage.

(2.3 The mentor teachers followed the process in Take Action stage collaborating with the student-teachers. The student-teachers took notes of the mentoring activities and rated their satisfaction about the mentor teachers' supervision.

(2.4) Results of mathematics learning and teaching management by the mentor teachers and the student-teachers were evaluated.

(2.5) The experts/university supervisors did follow-up assessments of the mentor teachers' performances periodically throughout the time frame prescribed in the program.

(2.6) The mentor teachers appraised their own competencies in the aspects of knowledge, skills, and attitudes after the program.

3.4.3 Sampling

The sample during this phase was broken into 2 groups:

1) A group of five volunteer mentor teachers majoring in mathematics selected by Lampang Rajabhat University.

2) A group of 10 volunteer student-teachers majoring in mathematics from Lampang Rajabhat University.

3.4.4 Instruments for data collection

1) A paper test for appraising mentor teachers' competencies promoting mathematics learning and teaching management in the 21st century in the aspect of knowledge and teaching professional development through a Professional Learning Community (PLC)

2) A scale for appraising mentor teachers' competencies promoting mathematics learning and teaching management in the 21st century in the aspect of skills and attitudes

3) An interview schedule for mentor teachers

4) A form for student-teachers to make notes about mentoring activities provided by mentor teachers

3.4.5 Development and validation of instruments

In this phase of study, four instruments were used for the data collection. The development and validation of the instruments were conducted as follows.

1) A paper test for appraising mentor teachers' competencies promoting mathematics learning and teaching management in the 21st century in the aspect of knowledge and teacher professional development through a Professional Learning Community (PLC)

(1) The related principles, concepts and theories were reviewed and a paper test for appraising the mentor teachers' knowledge of mathematics learning and teaching management and supervision in the 21st century was written.

(2) The test was presented to the three experts to examine its content validity and language clarity, and the Index of Congruence (IOC) was administered to explore the experts' opinions which were between 0.8-1.00. Adjustments were done as

suggested by the experts. The paper test contained 30 True/False questions carrying 30 marks.

2) A scale for appraising mentor teachers' competencies promoting mathematics learning and teaching management in the 21st century in the aspect of skills and attitudes.

A scale for appraising mentor teachers' competencies promoting mathematics learning and teaching management in the 21st century in the aspect of skills and attitudes was developed using the indicators in Phase 1. The scale's content validity and language clarity were examined, and the items with IOC of 0.80 and higher were considered. Additionally, the indicators with average scores at a high level and those at the highest level were selected according to the mentor teachers' opinions about the conditions of mathematics learning and teaching management in the 21st century, mentor teachers' supervision and needs for competencies development. The scale consisted of 17 items in the aspect of skills and 13 items in the aspect of attitudes.

3) An interview schedule for mentor teachers

The same interview schedule developed in Phase 3 of which the construct validity and language accuracy were already examined, and of which the IOC was 1.00 was used to note the answers of each mentor teacher.

4) A form for student-teachers to make notes about mentoring activities by mentor teachers following the competencies development process for mentor teachers promoting mathematics learning and teaching management in the 21st century.

The form was devised in response to the competencies development process for mentor teachers promoting mathematics learning and teaching management in the 21st century. It was a table showing details of the mentoring activities as well as suggestions provided by the mentor teachers, and the student-teachers' opinions towards the mentor teachers' supervision.

3.4.6 Data collection

1) An official letter from the Faculty of Education, Chiang Mai University dated 20 February 2016 requesting cooperation for data collection was sent to the Department of Mathematics, Lampang Rajabhat University.

2) Department of Mathematics, Lampang Rajabhat University implemented the model competencies development. In so doing, six volunteer teachers from four schools

including Anuban Maemoh School, Ban Maetha School, Sueksa Songkrah Chitaree Lampang School and Ban Fon Community School were selected to be the participants in the study. Then, an orientation meeting was held to provide information to the mentor teachers about the competencies development program for mentor teachers promoting mathematics learning and teaching management in the 21st century.

3) The mentor teachers started the procedure of the development program through the time frame determined by the Department of Mathematics, Lampang Rajabhat University which was from 31 March 2016 to 2 April 2016, and then the mentor teachers implemented the mentoring activities in collaboration with student-teachers in their respective schools from May to July in 2016, during which the experts/university supervisors carried out the follow-up performance assessments periodically.

4) The mentor teachers' competencies in the aspects of knowledge, skills and attitudes, as well as teaching professional development through a Professional Learning Community (PLC) were evaluated.

5) The mentor teachers were interviewed inquiring about the use of the development program including the strengths and things that need improvement in the development process, as well as their satisfaction about the use of the development scheme.

6) Student-teachers' notes about the mentoring activities conducted by the mentor teachers in response to the competencies development process for mentor teachers promoting mathematics learning and teaching management in the 21st century were collected.

7) Results of the mentor teachers' competencies evaluation, the mentor teachers' interviews, and student-teachers' notes about the mentoring activities conducted by the mentor teachers in response to the competencies development process for mentor teachers promoting mathematics learning and teaching management in the 21st century were analyzed.

8) Conclusions about the results of the use of the competencies development process for mentor teachers promoting mathematics learning and teaching management in the 21st century were finally made.

3.4.7 Data analysis

1) Descriptive statistics: relative gain score, mean, and standard deviation were used for the data analysis.

2) Content analysis was employed for student-teachers' notes about the mentoring activities.

Formulae for calculation

1) Percentage calculated here was operated using Relative Gain Score (RGS) initiated by Sirichai Kanchanawasi (1989) to show scores of the competencies relating to knowledge applying the following formula.

$$GS = \frac{(Y - X)}{(F - X)} \times 100$$

Where GS = percentage of students' learning development

F = total scores

X = scores gained from the first measurement

Y = scores gained from the last measurement

2) Mean (Frequency Distribution)

$$\mu = \frac{\sum fx}{\sum f}$$

3) Standard deviation (Frequency Distribution)

$$\sigma = \sqrt{\frac{\sum f(x-\mu)^2}{\sum f}}$$

Where μ = means of the population

σ = the standard of deviation of the population

f = number of those who answered the questionnaire

X = values of rating score as stated below

5 means the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes is at the highest level.

4 means the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes is at a high level.

3 means the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes is at a moderate level.

2 the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes is at a low level.

1 means opinions of mentor teachers toward their own competencies in the aspects of skills and an attitude is at the lowest level.

Criteria for data interpretation

1) Interpretation of the opinions of mentor teachers toward their own competencies in the aspect knowledge using percentage was carried out by benchmarking against the criteria of development analysis proposed by Sirichai Kanjanawasee (Kanjanawasee, 2013) as follows.

Percentage between 76-100 means mentor teachers' development is at a very high level.

Percentage between 76-100 means mentor teachers' development is at a high level.

Percentage between 76-100 means mentor teachers' development is at a moderate level.

Percentage between 76-100 means mentor teachers' development is at a low level.

2) Interpretation of the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes was carried out by benchmarking against the criteria of mean scores analysis and interpretation proposed by Best (John W. Best, 1970) as follows.

An average between 4.51-5.00 means the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes are at the highest level.

An average between 3.51-4.50 means the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes are at a high level.

An average between 2.51-3.50 means the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes are at a moderate level.

An average between 1.51-2.50 means the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes are at a low level.

An average between 1.00-1.50 means the opinions of mentor teachers toward their own competencies in the aspects of skills and attitudes are at the lowest level.