# CHAPTER 3

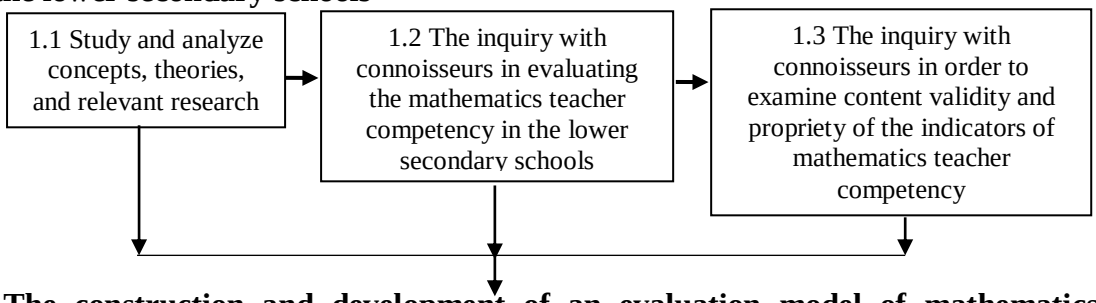
## Research Methodology

This research was considered a development of an evaluation model of mathematics teacher competency in the lower secondary school by means of the research and development. It consisted of research design details, population determination, and a sample group selection used in this research, research tool construction, data collection, and data analysis. The researcher divided the research into four steps as follows.

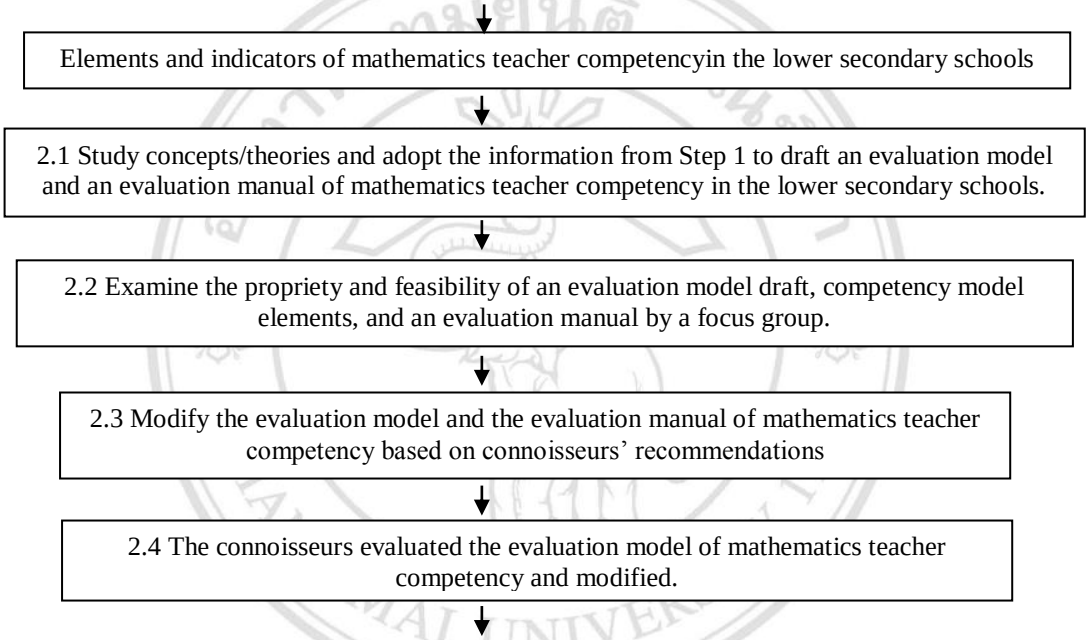
1. The analysis of elements and indicators of mathematics teacher competency in the lower secondary schools
2. The construction and development of an evaluation model of mathematics teacher competency in the lower secondary schools
3. An application result study on an evaluation model of the mathematics teacher competency in the lower secondary schools
4. Identification of guidelines to develop and enhance the mathematics teacher competency in the lower secondary schools

The summary of all four steps of the research methodology was illustrated in the following figure.

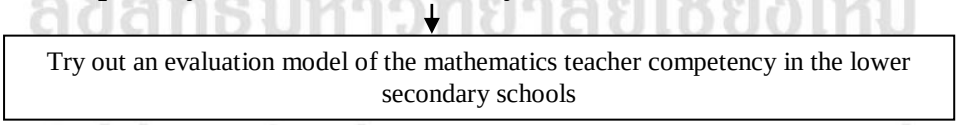
**1. The analysis of elements and indicators of mathematics teacher competency inthe lower secondary schools**




**2. The construction and development of an evaluation model of mathematics teacher competency in the lower secondary schools**




**3. An application result study on an evaluation model of the mathematics teachercompetency in the lower secondary schools**




**4. Identification of guidelines to develop and enhance the mathematics teachercompetency in the lower secondary schools**

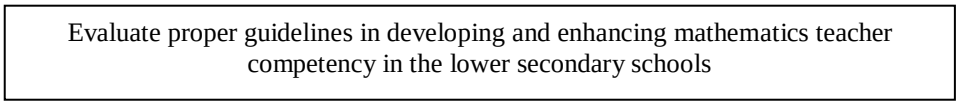



Figure 3.1 Research Methodology and Development of an Evaluation Model of Mathematics Teacher Competency in the Lower Secondary Schools

### 3.1 The analysis of elements and indicators of mathematics teacher competency in the lower secondary schools

The analysis of elements and indicators of mathematics teacher competency in the lower secondary school was divided into three steps aiming to determine necessary competency lists of mathematics teachers in the lower secondary school**s**. This was conducted by synthesizing documents and research relevant to mathematics teacher competency and analyzing elements in order to summarize into conceptual framework regarding competency elements and mathematics teacher competency lists as detailed below.

#### 3.1.1 Study and analyze concepts, theories, and relevant research

The synthesis of mathematics teacher competency sources from eight various sources and 25 research texts regarding mathematics teacher competency from 1990 to 2013 was conducted as follows.

**Data sources:**

There were two mathematics teacher competency sources.

1. Eight institutions or offices regarding mathematics teacher competency and educational personnel both domestic and international, namely the mathematics teacher competency of the Pennsylvania State University (2006), mathematics teacher standards of the Institute for the Promotion of Teaching Science and Technology (IPST: 2002), educational standards for evaluating external assessment (regarding teachers) (2001), teacher standards depending expertise level (2005), teacher competency of the Office of the Basic Education (2006), the synthesis of Thai teacher competency (2008), the synthesis of foreign teacher competency (2008), and teacher competency of Southeast Asia in the 21$^{st}$ century (2008).

2. The synthesis of 25 research texts regarding mathematics teacher competency from 1990 to 2013, namely Noppasak Yadtaku (1990), Adul Wangsrikoon (1990), Pratheuang Yensuang (1993), Kanoknan Wannapat (1997), Nittaya Choptham (1995), Sampan Intawong (1997), Rossaporn Tongrot (1998), Chalermpol Posri (1998),

Kullawadee Phaijit (2001), Jenvit Puangtumtim (2002), Pornthip Kaewtawee (2002), Surasak Onhom (2003), Thanaporn Homklin (2003), Kasem Boondee (2005), Inturat Weeradet (2004), Pikul Satitumpai (2005), Buddee Wutsela (2006), Montri Phuwikot (2007), Taweesak Suttipanyakan (2007), Piengjai Jongnok (2008), Piyaporn Siwasathorn (2008), Supapan Jaireun (2008), Wassana Sangngam (2008), Khawnjai Sritapak (2012), and Sakhaorat Jarungnantakan (2013).

**Data collecting tools:**

A data record form was used as a data collecting tool.

**Data collection:**

1. Gather and select relevant documents from various data sources, such as libraries, educational institutions, relevant offices, and electronic databases. The teacher competency information was examined by studying relevant documents and offices.

2. Search and synthesize teacher competency from the data gained by classifying based on 25 minor element issues of teacher competency. These were synthesized to study and classified into three key elements of mathematics teacher competency as follows.

   2.1 Competency on mathematics content knowledge

   2.2 Competency on mathematics learning management skills

   2.3 Competency on psychological factors in developing students, virtue, morality, and professional ethics

3. Examine in order to arranging minor elements of teacher competency gained from three key elements of mathematics teacher competency in the lower secondary school.

4. Record the synthesis results of considering teacher competency content from various sources in a record form which could be summarized in an overall picture into three key elements.

**Analysis methods and statistics employed:**

The content analysis was used.

### 3.1.2 The inquiry with connoisseurs in evaluating the mathematics teacher competency in the lower secondary school

In inquiring the connoisseurs, the researcher conducted as follows.

**Target groups:**

The target group consisted of five connoisseurs in mathematics teacher competency selected by purposive sampling method. They were connoisseurs possessing knowledge regarding mathematics teacher competency in the lower secondary school, namely mathematics teachers in the lower secondary school, instructors teaching students majoring in mathematics, educational supervisors in mathematics in the secondary school.

**Data collecting tools:**

A questionnaire was used to examine the inclusion of indicators on mathematics teacher competency in the lower secondary school.

**Tool construction steps:**

1. Study concepts, documents, and research relevant to mathematics teacher competency in order to be guidelines in drafting an opinion questionnaire covering mathematics teacher competency in the lower secondary school.

2. Draft the questionnaire to cover mathematics teacher competencymathematics teacher competency in the lower secondary school with 25 lists of competency.

3. Propose the questionnaire to the connoisseurs to examine accuracy, propriety of language, and inclusion of the question items with mathematics teacher competency in the lower secondary school.

4. Adopt the recommendations gained to adjust and improve language and the inclusion in order to prepare a questionnaire draft for the following steps

**Data collection:**

1. Send letters from Faculty of Education, Chiang Mai University to five connoisseurs the researcher contacted and coordinated in person in order to ask for assistance in answering the questionnaire. The researcher received the answered questionnaires in person and asked them to partially return to the researcher by post.

2. The researcher examined the accuracy and completeness of the questionnaires.

**Data analysis and statistics employed:**

The data and the recommendations of the connoisseurs were analyzed by means of content analysis for the sake of the inclusion.

**3.1.3 The inquiry with connoisseurs in order to examine content validity and propriety of the indicators of mathematics teacher competency**

**Target groups:**

This was a group of 17 connoisseurs selected by purposive sampling method. Their qualification was as follows.

1. Six connoisseurs on curriculum and mathematics teaching methods in higher education who taught students the mathematics teaching
2. Three educational supervisors in mathematics in the secondary level
3. Three connoisseurs on measuring, assessing, and developing elements
4. Two administrators in secondary schools specializing in teaching and learning mathematics
5. Three mathematics teachers in the lower secondary school holding academic standing at a level of or higher than a specialist or outstanding mathematics teachers at a provincial level having at least ten years of teaching experience

**Data collecting tools:**

The tool used to collect data was a set of an opinion questionnaire for connoisseurs regarding examining on content validity of the indicators on mathematics teacher competency in the lower secondary school. It consisted of three parts as follows.

Part 1contained a group of indicators in an element of mathematics content knowledge competency.

Part 2 contained a group of indicators in an element of mathematics learning management skill competency.

Part 3 contained a group of indicators in a competency element of psychological factors in developing students, virtue, morality, and professional ethics.

**Steps of constructing a questionnaire in order to evaluate content validity and propriety of the indicators of mathematics teacher competency in the lower secondary school:**

The questionnaire construction was conducted by the following steps.

1. Construct a questionnaire from 25 items of mathematics teacher competency elements gained from the synthesis in Step 3.1.1 and suggestions given by the connoisseurs for the sake of convenience in evaluating mathematics teacher competency in the lower secondary school. The 65 indicators were then received.

2. Examine the questionnaire quality in terms of content inclusion, accuracy, and language clarity from five connoisseurs in order to improve later.

**Data collection:**

1. Compose the letters from Faculty of Education, Chiang Mai University to five connoisseurs a target group of connoisseurs in order to ask for assistance in answering the questionnaire.

2. The researcher sent the assistance letters and the questionnaires to the target group of the connoisseurs in person and asked them to return to the researcher by post.

3. The researcher examined the accuracy and completeness of the questionnaires.

**Analysis methods and statistics employed:**

The analysis methods were conducted by means of the Item-Objective Congruence Index (IOC) between question items and mathematics teacher competency needed to be

measured, mean, and standard deviation of the indicators whether they were proper for being used to evaluate the mathematics teacher competency or not.

### 3.1.4 The analysis of elements and indicators of mathematics teacher competencyin the lower secondary school

**Population:**

The population consisted of 14,361 mathematics teachers in 7,329 lower secondary schools under the Office of the Basic Education Commission. It was divided as follows.

3,714 teachers from the Office of Primary Educational Service Area
10,647 teachers from the Office of Secondary Educational Service Area

In terms of school sizes, it was divided into the followings (the Bureau of Policy and Planning for Basic Education: 2013).

3,835 teachers from 1,258 big-sized schools
7,128 teachers from 3,504 medium-sized schools
3,398 teachers from 2,567 small-sized schools

**Sampling groups:**

In selecting mathematics teachers in the lower secondary school randomly, the sample size was determined based on the concept of the factor analysis in that there were ten times of a variable number or not less than 500 items (Kanlaya Wanitbancha: 2006). As for this research, a questionnaire selected and given opinions from all of the connoisseurs on 63 indicators was determined for a sample size scope which was ten times of the variable number or at least 500 items by means of multi-stage random sampling method. The operation was performed as follows.

1. The area was divided into six regions which were nine provinces in the North, 21 provinces in the Central, 20 provinces in the Northeast, five provinces in the

West, 14 provinces in the South, and seven provinces in the East by means of randomly selecting the provinces on a ratio of the number of provinces in each region.

1.1 Three provinces in the North which were Chiang Mai, Chiang Rai, and Lampang

1.2 Seven provinces in the Central which were Bangkok, Pathumthani, Uthaithani, Petburee, Ayudthaya, Phitsanuloke, and Suphanburee

1.3 Seven provinces in the Northeast which were Knonkaen, Ubonratchathanee, Srisaket, Nakhonratchaseema, Udornthani, Buriram, and Udonthani

1.4 Two provinces in the West which were Tak and Kanchanaburi

1.5 Five provinces in the South which were Prajuabkirikhan, Songkla, Nakhonsrithammarat, Phang-nga, and Phuket

1.6 Two provinces in the East which were Chanthaburi and Rayong

2. In each province, schools were divided based on their affiliation under the Office of Primary Educational Service Area and the Office of Secondary Educational Service Area randomly selected on a basis of a ratio of 1:3 between the schools under the Office of Primary Educational Service Area and the Office of Secondary Educational Service Area.

3. In the schools under the Office of Primary Educational Service Area and the Office of Secondary Educational Service Area, they were divided in terms of their size, namely big, medium, and small schools. They were randomly selected based on a ratio of 1: 2: 1 among the big schools, moderate schools, and small schools.

4. Mathematics teachers from the schools in Step 3 were performed by a method of simple random sampling to get two teachers from the big-sized schools, three from the medium-sized schools, and one from the small-sized schools.

5. According to the ratio determination of the mathematics teachers based on the school size, 970 questionnaire copies sent were returned to the researcher 753 copies or 77.63 percent. They were then analyzed by means of the factor analysis, and 633 copies were able to be used. This was equivalent to 84.06 percent which was enough to be analyzed by means of the factor analysis at a level of ten times of the variable number or at least 500 items (Kanlaya Wanitbancha: 2006).

**Data collecting tools:**

A set of opinion questionnaire of indicators regarding mathematics teacher competency in the lower secondary school consisted of two parts as follows.

Part I of the questionnaire consisted of the general information of a respondent which was gender, age, school location, school affiliation, school size, mathematics degree, mathematics class levels, and mathematics teaching experience. The questionnaire was in a form of a check-list and blank filling.

Part II of the questionnaire consisted of the opinions toward the indicators of mathematics teacher competency and guidelines for developing mathematics teacher competency in the lower secondary school. This inquired opinions of the level of importance of the indicators regarding the elements of mathematics teacher competency in the lower secondary school in the following three groups as follows.

Group 1 consisted of 26 indicators in the elements of mathematics content knowledge competency in the lower secondary school.

Group 2 consisted of 25 indicators in the elements of mathematics learning management skill competency in the lower secondary school.

Group 3 consisted of 12 indicators in the elements of competency regarding psychological factors in developing students, virtue, morality, and professional ethics.

The questionnaire was close-ended in a 5-rating scale with a criteria in selecting answers and determining scores in each level from one to five scores as follows.

"5" meant "this indicator was extremely important/necessary."
"4" meant "this indicator was considerably important/necessary."
"3" meant "this indicator was moderately important/necessary."
"2" meant "this indicator was insignificantly important/necessary."
"1" meant "this indicator was least important/necessary."

The interpretation criteria of results was as follows (Boonchom Srisaard: 2010)

An average of 4.51-5.00 indicated that "the indicator was extremely important/necessary."

An average of 3.51-4.50 indicated that “the indicator was considerably important/necessary.”

An average of 2.51-2.50 indicated that “the indicator was moderately important/necessary.”

An average of 1.51-2.50 indicated that “the indicator was insignificantly important/necessary.”

An average of 1.00-1.50 indicated that “the indicator was least important/necessary.”

**A questionnaire sample:**

Competency 1 consisted of the indicators in an element regarding competency in content knowledge and teaching method knowledge.

Table 3.1 A Questionnaire Sample

| **Indicators of Mathematics Teacher Competency** | **Necessity and appropriateness Levels** | | | | | **Recommendations** |
|---|---|---|---|---|---|---|
| | **5** | **4** | **3** | **2** | **1** | |
| 1. Possess knowledge in content, numbers, and performance in the lower secondary school.<br>2. Possess knowledge regarding systems, structures, concepts, and nature of mathematics.<br>3. ..... | | | | | | |



**Tool construction steps:**

1. Adopt 63 indicators to construct an opinion questionnaire on a 5-rating scale form in order to inquire importance and necessity of each indicator of mathematics teacher competency in the lower secondary school.

2. Adopt Part 2 of the questionnaire to try out with administrators, mathematics teachers, and teacher peers in a total of 34 people in the lower secondary schools under the Office of the Basic Education Commission, namely the Office of Primary Educational Service Area I, Chiang Mai and the Office of Secondary

Educational Service Area 34, Chiang Mai-Mae Hong Son. The gained data was analyzed for the reliability of the entire questionnaire on a basis of Cronbach's Alpha Coefficient which was 0.92. After that, the recommendations were summarized and prepared for an actual questionnaire later.

**Data collection:**

1. Send letters from Faculty of Education, Chiang Mai University to administrator of educational institutions and sample groups of this research in order to ask for assistance in answering the questionnaire. Letter envelopes with postage attached and the researcher's name and address were included in order for them to return by post.

2. The researcher gathered and examined the accuracy and completeness of the questionnaires.

**Data analysis methods and statistics employed:**

The data analysis was conducted by a statistical package as shown in the following steps.

1. Part 1 of the questionnaire was a general analysis of a sample group on a basis of fundamental statistics, namely description statistics of frequency and percentage.

2. Part 2 of the questionnaire analyzed the fundamental statistics and Exploratory Factor Analysis (EFA) by extracting factors by means of principal component analysis and rotating axes by means of varimax orthogonal rotation. The statistical package was employed in order to group factors of mathematics teacher competency in the lower secondary school as follows.

2.1 Analyze fundamental statistics on importance of the indicators of mathematics teacher competency in the lower secondary school by means of mean and standard deviation.

2.2 Interpret the results of the standard deviation of the indicators on mathematics teacher competency in the lower secondary school by expressing opinion dispersion of mathematics teachers toward teacher competency indicators.

2.3 Analyze factors of mathematics teacher competency by the statistical package as follows.

2.3.1 Calculate the correlation coefficient value in order to identify the correlation of each pair of variables.

2.3.2 Adopt the variables correlating with other variables significantly to extract factors by analyzing key factors. The analysis identifying correlations among variables of 63 indicators was performed on a criteria of more than 0.30 correlation. If any indicator matched this criteria, it was usable. It was found that the indicators of mathematics teacher competency were matched the criteria of 63 indicators.

2.3.3 Rotate axes by means of varimax orthogonal rotation and consider factors possessing the Eigen value at a level of "1" or more than "1" with more than three descriptive variables of that factor. Each variable had to contain the factor loading of more than 0.30. According to the factor loading analysis result, there was no indicator that contained the factor loading less than 0.30. Therefore, they could be adopted to be 63 indicators.

2.3.4 Adopt the factor analysis results to interpret and determine element names, it was found that there were eight elements and 63 indicators of mathematics teacher competency in the lower secondary school.

## 3.2 The construction and development of an evaluation model of mathematics teacher competency in the lower secondary schools

The construction and development of an evaluation model of mathematics teacher competency in the lower secondary school was divided into four steps as detailed below.



### 3.2.1 Draft an evaluation model of mathematics teacher competency in the lower secondary school and evaluation manual

This step aimed at determining an element structure frame of an evaluation model of mathematics teacher competency in the lower secondary school by analyzing relevant documents. It was performed as follows.

**The target groups and data sources** were articles, research findings, concepts, theories regarding an evaluation of performance results of educational personnel, the concepts regarding ten questions of Nevo (1983), and an evaluation of teacher profession standards disseminated in textbooks, books, journals, and other electronic media.

**Research tools:**

The research tool was a data record form which was an open-ended questionnaire used to record an evaluation model of mathematics teacher competency. It was constructed as follows.

1. Study Nevo's concepts used as the concepts for ten key questions. Record them as a draft of an evaluation model of mathematics teacher competency in the lower secondary school. The key elements of drafting the evaluation model were (1)evaluation definition, (2) roles and duties of an evaluation model, (3) evaluation goals, (4) evaluated variables, (5) evaluation criteria, (6) those who applied the evaluation results, (7) result evaluation steps, (8) evaluation methods, (9) evaluating assessors, and (10) evaluation standards in judging the evaluation.

2. Produce a record form in drafting an evaluation model of mathematics teacher competency in the lower secondary school and record the key elements of a model draft which were (1) evaluation goals, (2) evaluation scope, (3) evaluation regarding assessor qualification, evaluation tools, and evaluation methods, (4) evaluation result judgment, and (5) result reporting and evaluation result application in examining accuracy.

3. Propose a model draft record to three connoisseurs for further inspecting on inclusion, language accuracy, its accuracy, and propriety.



**Data collection:**

1. Study documents and research regarding evaluation model development, concepts of various types of evaluation, including considering element and indicators gained from Step 3.1.

2. Adopt the information from Step 3.1 to be combined in drafting an evaluation model based on Nevo's principal concepts of ten key questions.

3. Gather data gained from a record form and documents gathered regarding an evaluation model of operational results of personnel from libraries, educational institutions, and electronic database to be used as guidelines in drafting an evaluation model of mathematics teacher competency in the lower secondary school.

4. Synthesize element content of evaluating teacher competency. It was found that an evaluation model of teacher competency consisted of five key elements which were (1) evaluation goals, (2) evaluation scopes, (3) evaluation operation, (4) evaluation result judgment, and (5) evaluation result application. In terms of a model from a general system theory of Von Bertalanffy (1968), it consisted of four elements which were inputs, processes, outputs, and feedback.

5. Construct an evaluation model by determining structures and details of various parts, such as evaluation goals, evaluation scopes, evaluation operation, evaluation result judgment, evaluation results, and evaluation result application which were detailed as follows.

5.1 The evaluation goals were the mathematics teachers in the lower secondary schools holding qualification matching with their major and those whose majors were not matched.

5.2 The evaluation scopes consisted of a competency scope of mathematics teachers in the lower secondary schools in eight elements and 63 indicators as follows.

5.2.1 The knowledge element in mathematics content

5.2.2 The knowledge element regarding mathematics content teaching methods

5.2.3 The knowledge element regarding curriculum goals, innovative media application, and relevant fundamental knowledge

5.2.4 The knowledge element regarding mathematics curriculum and curriculum application

5.2.5 The skill element in mathematics learning management

5.2.6 The skill element in solving student problems and self-development

5.2.7 The skill element in developing students

5.2.8 The psychological factor element in developing students, virtue, morality, professional ethics

The evaluation operation consisted of the elements as follows.

1. Assessors who were as follows.
   1.1 Administrators or assigned representatives
   1.2 Teacher peers
   1.3 Teachers evaluated themselves
   1.4 Students
2. Tools which were as follows.
   2.1 A testing form
   2.2 A check-list form
   2.3 An opinion questionnaire on a rating scale
3. Evaluation methods
   3.1 Testing
   3.2 Observation and self-assessment
   3.3 Examination of evidence and documents
   3.4 An evaluation time period which was set to perform once a semester
4. Evaluation result judgment which were as follow
   4.1 Evaluation criteria
   4.2 A data processing program
5. Competency evaluation results and result application
   5.1 Evaluation result reporting, overall data, and individual data
   5.2 Developing and enhancing math teacher competency guidelines
   5.3 Judgment of development guideline determination
6. Propose the draft of an evaluation model of mathematics teacher competency in the lower secondary school to three connoisseurs in order for them to examine language, completeness, and accuracy, including giving suggestions for further improvement for the sake of more accuracy and propriety.

**Data analysis:**

The data analysis was conducted by the content analysis.

**Steps of constructing a manual to evaluate mathematics teacher competency in the lower secondary school**

Apart from constructing an evaluation model of mathematics teacher competency, the researcher constructed a manual to evaluate the competency in order to have guidelines in operating the evaluation on mathematics teacher competency in the lower secondary school. The operational steps were as follows.

1. Determine goals of constructing an evaluation manual and study the concepts and principles of constructing an evaluation manual of personnel competency from various sources in order to be used as a guideline in constructing the manual.

2. Adopt the data gained from the results of developing an evaluation model of competency to set a frame in presenting in the manual of mathematics teacher competency evaluation. The important parts were as follows.

2.1 A conceptual framework of an evaluation model of mathematics teacher competency in the lower secondary school

2.2 Evaluation goals

2.3 Evaluation scopes

2.4 Evaluation operation

2.5 Evaluation result judgment

2.6 Result reporting and evaluation result application

2.7 Competency evaluation result summary

3. Propose a manual draft of the evaluation in mathematics teacher competency in the lower secondary school which presented the content of an evaluation model to five connoisseurs in order for them to inspect propriety, accuracy, inclusion, and language clarity. After that, improve and correct as suggested in order to modify its propriety.

4. Propose a manual of competency evaluation to 11 connoisseurs in order for them to inspect propriety, inclusion, and clarity, including giving further recommendations.

**Steps of developing tools within an evaluation model of teacher competency in the lower secondary school**

The steps of developing tools within an evaluation model of teacher competency consisted of the following steps.

1. Determine goals and scopes of the evaluation. In other words, it was a determination of evaluation objectives and elements used to evaluate. The evaluation scopes were gained from the factor analysis in Step 3.1.

2. Determine evaluation methods. It was a determination of methods used to gain data for making decisions at a level of competency. It consisted of evaluating tool construction and evaluating method determination by adopting competency and the indicators gained from Step 3.1 to construct tools in the following steps.

2.1 Consider and select evaluating tools that were appropriate as set in the definition of competency evaluated. In this step, there was a consideration in measuring whether each mathematics teacher contained competency in those aspects or not and how to measure them.

2.2 Consider an evaluation form used to measure each element in terms of mathematics content knowledge, mathematics learning management skill, and psychological factors in developing students, virtue, morality, and professional ethics. According to the consideration results of all competency items, it was found that this evaluation form consisted of the followings.

2.2.1 An objective test on mathematics content knowledge

2.2.2 A check-list on mathematics learning management skills

2.2.3 A rating scale form on psychological factors in developing students, virtue, morality, and professional ethics

3. Construct two types of tools to evaluate mathematics teacher competency. Each tool consisted of the constructing procedure as follows.

3.1 Three copies of a knowledge test on mathematics content in the secondary level which consisted of a knowledge test on six groups of mathematics learning content, a knowledge test on six groups of mathematics learning content

teaching methods, and a knowledge test on curriculum and mathematics curriculum application. They were constructed as follows.

3.1.1 Study documents and research relevant to the competency evaluation and adopt the inquiry results gained from the connoisseurs to synthesize as an overall aspect of an evaluation of mathematics teacher competency. The guideline of evaluating mathematics teacher competency in terms of mathematics content knowledge was gained.

3.1.2 Determine the objectives of evaluating competency, key competency of an evaluation, minor competency of an evaluation on mathematics teacher competency, evaluation indicators, and the number of examination items, including preparing a table of analyzing and planning.

3.1.3 Construct three copies of the knowledge test on mathematics content in the lower secondary school as follows.

Copy 1: A knowledge test on six groups of mathematics learning content containing 96 items

Copy 2: A knowledge test on six groups of mathematics learning content teaching methods which contained 84 items

Copy 3: A knowledge test on curriculum and mathematics curriculum application containing 132 items

3.1.4 Adopt the constructed tests to the connoisseurs in order for them to inspect structural validity, content validity, and the congruence between tools and indicators by means of the Item-Objective Congruence Index (IOC). It was found that the tests contained the IOC in each particular item between 0.80 and 1.00. The researcher modified on a basis of the recommendations from the connoisseurs.

3.1.5 Adopt the modified tests to try out with 67 mathematics teachers in the Primary Educational Service Area 2, Chiang Mai, in order to inspect clarity in conveying meaning of each message in each item, difficulty, and discrimination power of the tests, respectively.

3.1.6 Adopt all three copies of the tests to analyze the difficulty value and discrimination power. After that, select only the items containing the difficulty value between 0.20 and 0.80 and the discrimination power more than 0.20. The tests were selected as follows.

Copy 1: A knowledge test on six groups of mathematics learning content in the lower secondary school containing 60 items. It was found that the difficulty value was .22- and .78, and the discrimination power value between .22- and .78.

Copy 2: A knowledge test on six groups of mathematics learning content in the lower secondary school and teaching methods which contained 60 items. It was found that the difficulty value was .21- and .75, and the discrimination power value between .23- and .78.

Copy 3: A knowledge test on curriculum and curriculum application containing 80 items. It was found that the difficulty value was .21- and .78, and the discrimination power value between .25- and .61.

3.1.7 Try out all three copies of the tests with 37 mathematics teachers in the lower secondary schools under the Office of Primary Educational Service Area I and the Office of Secondary Educational Service Area 34, Chiang Mai. After that, the reliability of all three was analyzed which was 0.72, 0.75, and 0.77, respectively.

3.2 An evaluation form of mathematics learning content skills in the lower secondary school and an evaluation form of competency on psychological factors in developing students, virtue, and morality. They were in a form of check-list tests consisting of as follows.

3.2.1 An evaluation form of the competency on mathematics learning management skills in the lower secondary school which was a check-list of 14 items

3.2.2 An evaluation form of the competency on solving student problems and self-development skills which was a check-list of five items

3.2.3 An evaluation form of the competency on student development skills which was a check-list of six items

3.2.4 An evaluation form of the competency on psychological factors in developing students, virtue, morality, and professional ethics which was a 5-rating scale of 12 items

The steps of constructing tools were as follows.

1. Study documents and research regarding competency evaluation in order to construct a competency evaluation form based on the indicators by means of the factor analysis in Step 3.1

2. Construct three copies of a competency evaluation form of mathematics learning management skills in the lower secondary school in three aspects and 31 items and one copy of a competency evaluation form of psychological factors in developing students, virtue, morality, and professional ethics in 12 items.

3. Adopt all three sets of the tools to the connoisseurs in order for them to inspect indicator congruence to evaluate mathematics teacher competency. It was found that the competency criteria were able to be measured in accordance with the indicators of mathematics teacher competency in the lower secondary school possessing the Item-Objective Congruence Index (IOC) between 0.80 and 1.00 in every item.

4. Modify and correct the evaluation form. After that, try out with 21 mathematics teachers in schools under the Offices of Primary Educational Service Area I and II and 13 mathematics teachers in schools under the Office of Secondary Educational Service Area 34, Chiang Mai. The total number of teachers was 34. Besides, the evaluation form was tried out by allowing the teacher peers and administrators observed mathematics teacher behaviors for about three weeks. Then, the results were analyzed by identifying the discrimination power value and the reliability value of the evaluation form. It was found that every item contained the discrimination power value which was statistically significant at a level of .05 in every evaluated item. The reliability value of all four copies of the evaluation form, namely an evaluation form of the competency on mathematics learning management skills, an evaluation form of the competency on solving student problems and self-development skills, an evaluation form of the competency on student development skills, and an evaluation form of the competency on psychological factors in developing students, virtue, morality, and professional ethics, was 0.92, 0.81, 0.83, and 0.88, respectively

5. Produce all four copies of the evaluation forms to be used as the tools for collecting further data.

**Data analysis methods:**

The data analysis was performed by identifying the difficulty value, the discrimination power value, validity, and reliability.

**3.2.2 A focus group in order to consider an evaluation model and evaluate propriety and feasibility of the evaluation model of evaluating mathematics teacher competency**

The results of examining the quality of an evaluation model of mathematics teacher competency in in the lower secondary school were divided in two parts as follows.

**3.2.2.1 The examination on the propriety of the element evaluation model draft of an evaluation model of competency and an evaluation manual by a focus group**

This step aimed at inspecting the quality of an evaluation model of competency and an evaluation manual of mathematics teacher competency in the lower secondary school by connoisseurs in terms of propriety and feasibility.

**Target groups:**

The target groups used in the focus group in order to consider an evaluation model and an evaluation manual of mathematics teacher competency, namely two administrators in secondary schools possessing fundamental knowledge regarding mathematics teaching and learning, two mathematics educational supervisors, three university instructors teaching mathematics students, two connoisseurs in measuring, evaluating, and an evaluation model, and two mathematics teachers in the lower secondary school specializing in teaching. The total number was 11 people.

**Research tools:**

**1. A questionnaire on propriety of an evaluation model of mathematics teacher competency in the lower secondary school**

This was a questionnaire used to consider the propriety of the elements of an evaluation model of mathematics teacher competency. The steps in constructing an evaluation

form toward propriety of the evaluation model of mathematics teacher competency in the lower secondary school were as follows.

1.1 Study documents and research relevant to a focus group and a construction of evaluating propriety of an evaluation model of competency. The data gained were adopted to construct question items for the connoisseurs in order for them to evaluate a model in terms of key elements, such as evaluation goals, evaluation scopes, evaluation performance, evaluation result judgment, evaluation results, result application, and an evaluation manual of competency. The question issues were constructed to cover an evaluation model of mathematics teacher competency in the lower secondary school.

1.2 Propose to three connoisseurs in order to be inspected for propriety of the items evaluating the evaluation model of mathematics teacher competency, the propriety of the language used, inclusion, and recommendations of the evaluated items.

1.3 Adopt the gained recommendations to modify an evaluation model of competency for further application.

**Data collection:**

The data were collected as detailed below.

1. Send letters from Faculty of Education, Chiang Mai University, to ask for assistance from connoisseurs in a focus group so that they could participate in considering propriety and recommendations toward an evaluation model of mathematics teacher competency as listed in the evaluation items.

2. Send an evaluation manual of teacher competency together with an evaluation form regarding an evaluation model of mathematics teachers to the connoisseurs for their consideration two weeks in advance.

3. The researcher made an appointment of date, time, and place for a focus group.

4. Operate a focus group by allowing the connoisseurs to consider together and give opinions based on topics and issues to draw conclusion and key elements of an evaluation model of mathematics teacher competency in every item.

**Data analysis methods and statistics employed:**

The content analysis of element propriety of an evaluation model and an evaluation manual of mathematics teacher competency were employed.

**3.2.2.2 The connoisseurs evaluated an evaluation model of mathematics teacher competency**

This step aimed at inspecting the quality of an evaluation model of competency and an evaluation manual of competency for the second round. The researcher conducted as follows.

**Target groups:**

The target groups used in evaluating an evaluation model of mathematics teacher competency and an evaluation manual of mathematics teacher competency consisted of two connoisseurs in measuring and evaluating in education, two mathematics educational supervisors, three connoisseurs in curriculum and mathematics teaching, and two connoisseurs in teaching mathematics in the lower secondary school. The total number was nine people.

**Research tools:**

1. An evaluation form of an evaluation model of mathematics teacher competency in the lower secondary school which was a 5-rating scale form.
2. An evaluation form toward an evaluation manual of mathematics teacher competency in the lower secondary school which was a 5-rating scale form.



**Data collection:**

In collecting data for evaluating an evaluation model of mathematics teacher competency in the lower secondary school and an evaluation manual of evaluating competency for the second round, the researcher operated as follows.

1. Send the questionnaires in person to nine connoisseurs in order for them to evaluate and express opinions toward an evaluation model of mathematics teacher competency and an evaluation manual of mathematics teacher competency by post.

2. The target group of connoisseurs sent the questionnaires back to the researcher by post.

3. Inspect accuracy, inclusion, and completeness of the questionnaire.

4. Adopt the data gained to modify an evaluation model of mathematics teacher competency and an evaluation manual of mathematics teacher competency.

**Data analysis methods:**

The data were analyzed by means of mean and standard deviation and then compared with the interpretation criteria as follows.

An average of 4.51-5.00 meant an opinion was at the highest level.

An average of 3.51-4.50 meant an opinion was at a high level.

An average of 2.51-3.50 meant an opinion was at a moderate level.

An average of 1.51-2.50 meant an opinion was at an insignificant level.

An average of 1.00-1.50 meant an opinion was at the least level.

The quality inspection results of an evaluation model of mathematics teacher competency in the lower secondary school were divided into two parts as follows.

**1. The consideration results of the quality of an evaluation model of mathematics teacher competency**

Nine connoisseurs consisting of school administrators specializing in mathematics teaching and learning management, mathematics educational supervisors, university instructors teaching mathematics students, connoisseurs in curriculum and mathematics teaching methods were inquired in order for them to consider the quality of the evaluation model in terms of these four aspects, namely (1) utility, (2) feasibility, (3) moral propriety, and (4) accuracy. The consideration results were shown in the following table.

Table 3.2 Mean, Standard Deviation, and the Opinion Level of the Connoisseurs toward the Quality of a Manual in terms of Utility Standard

| Item Evaluated | $\mu$ | $\sigma$ | Level |
|---|---|---|---|
| 1. An evaluation model of mathematics teacher competency gave useful information for those relevant in determining guidelines in developing and enhancing mathematics teacher competency. | 4.76 | 0.44 | Highest |
| 2. The information gained from an evaluation of mathematics teacher competency was useful toward those evaluated. | 4.67 | 0.50 | Highest |
| 3. An evaluation model of mathematics teacher competency enabled educational institutions to get ready for their quality assurance. | 4.56 | 0.73 | Highest |
| 4. An evaluation model of mathematics teacher competencywas supposed to be promoted to be used as a guideline in evaluating teacher competency in other subject content so as to develop their work resulting in better operational efficiency. | 4.67 | 0.50 | Highest |
| 5. The information gained from evaluating mathematics teacher competency could be utilized in developing administrative quality of schools. | 4.56 | 0.53 | Highest |
| 6. The information gained from evaluating mathematics teacher competency could be used to solve problems so that competency evaluation would be fair and transparent. | 4.56 | 0.73 | Highest |
| 7. An evaluation model of mathematics teacher competency clearly identified those relevant to the evaluation. | 4.89 | 1.33 | Highest |
| 8. The information gained from evaluating mathematics teacher competency and assessors was reliable. | 4.78 | 0.44 | Highest |
| 9. Data collection covered mathematics teacher competency in the lower secondary level and responded needs in applying the evaluation results. | 4.78 | 0.44 | Highest |
| 10. The interpretation and the evaluation result judgment of teacher competency was clear. | 4.44 | 0.73 | Highest |
| 11. An evaluation model of mathematics teacher competency in the lower secondary level was acceptable. | 4.56 | 0.53 | Highest |

Table 3.2 (continued)

| Item Evaluated | $\mu$ | $\sigma$ | Level |
|---|---|---|---|
| 12. An evaluation model of mathematics teacher competencywas supposed to be promoted to be used in evaluating mathematics teacher competency in the lower secondary level. | 4.67 | 0.53 | Highest |
| **Overall** | **4.66** | **0.53** | **Highest** |

According to Table 3.2, the quality evaluation in an aspect of utility standard in an overall aspect was at the highest level with a mean of 4.66 and standard deviation of 0.53. When considering each particular item, it was found that all of them possessed a mean at a level of the highest with a mean between 4.44-4.89. "An evaluation model of mathematics teacher competency clearly identified those relevant to the evaluation" showed the highest average of 4.89.

Table 3.3 Mean, Standard Deviation, and the Opinion Level of the Connoisseurs toward the Quality of a Manual in terms of Feasibility Standard

| Item Evaluated | $\mu$ | $\sigma$ | Level |
|---|---|---|---|
| 1. This evaluation model of mathematics teacher competency in the lower secondary level could be used to actual practices. | 4.56 | 0.53 | Highest |
| 2. The model, methods, and evaluation results of mathematics teacher competency were acceptable among those relevant. | 4.56 | 0.53 | Highest |
| 3. The evaluation results of mathematics teacher competency was worth in terms of time, expense, and resources. | 4.33 | 0.71 | High |
| 4. An evaluation model could be used as a part of assuring educational quality of schools. | 4.89 | 0.33 | Highest |
| 5. An evaluation model of mathematics teacher competency could be understood easily. | 4.33 | 0.87 | High |
| **Overall** | **4.53** | **0.63** | **Highest** |

According to Table 3.3, the quality evaluation in an aspect of feasibility standard in an overall aspect was at the highest level with a mean of 4.53 and standard deviation of 0.63. When considering each particular item, it was found that all of them possessed a mean at a level more than high with a mean between 4.33-4.89. "An evaluation model could be used as a part of assuring educational quality of schools" possessed the highest average of 4.89.

Table 3.4 Mean, Standard Deviation, and the Opinion Level of the Connoisseurs toward the Quality of a Manual in terms of Moral Propriety Standard

| | **Item Evaluated** | $\mu$ | $\sigma$ | **Level** |
|---|---|---|---|---|
| 1. | This evaluation model of teacher competency was proper in evaluating mathematics teacher competency in the lower secondary level. | 4.67 | 0.50 | Highest |
| 2. | The steps in evaluating mathematics teacher competency as set in this model were properly used. | 4.44 | 0.73 | High |
| 3. | An evaluation model of mathematics teacher competency identified what needed to be evaluated clearly. | 4.67 | 0.50 | Highest |
| 4. | This evaluation model of mathematics teacher competency was harmonious and responsive toward teacher performance evaluation as set in a policy of the Office of the Basic Education Commission. | 4.67 | 0.50 | Highest |
| 5. | The evaluation result reporting of teacher competency was complete and fair presenting strengths and guidelines in developing and enhancing mathematics teacher competency. | 4.56 | 0.53 | Highest |
| 6. | Those evaluating teacher competency determined in this model were reliable. | 4.56 | 0.53 | Highest |
| 7. | The criteria of evaluating the results of mathematics teacher competency could be used to measure the mathematics teacher competency. | 4.56 | 0.53 | Highest |
| 8. | The tools used to evaluate the results of mathematics teacher competency could be used to measure the mathematics teacher competency. | 4.67 | 0.50 | Highest |
| 9. | The evaluation result reporting on mathematics teacher competency in the lower secondary level was complete in terms of content. | 4.67 | 0.50 | Highest |
| | **Overall** | **4.67** | **0.50** | **Highest** |

According to Table 3.4, it was found that the quality evaluation in an aspect of propriety standard in an overall aspect was at the highest level with a mean of 4.67 and standard deviation of 0.05. When considering each particular item, it was found that most of them possessed a mean at a level of high to the highest with a mean between 4.44-4.67. "The steps in evaluating mathematics teacher competency as set in this model were properly used" possessed the lowest average while those of the others were at the highest level.

Table 3.5 Mean, Standard Deviation, and the Opinion Level of the Connoisseurs toward the Quality of a Manual in terms of Accuracy Standard

| | **Item Evaluated** | $\mu$ | $\sigma$ | **Level** |
|---|---|---|---|---|
| 1. | An evaluation model explained objectives and goals clearly. | 4.78 | 0.44 | Highest |
| 2. | An evaluation model of mathematics teacher competency in was flexible in using techniques to collect data of various methods resulting in getting accurate evaluation results. | 4.67 | 0.50 | Highest |
| 3. | Information gained from evaluating mathematics teacher competency covered sufficiently in that it could be used to make decisions among administrators and teachers evaluated. | 4.56 | 0.53 | Highest |
| 4. | A report of evaluation results on mathematics teacher competency was valid. | 4.56 | 0.53 | Highest |
| 5. | Evaluation results gained from an evaluation model of mathematics teacher competency were accurate matching an actual condition in educational institutions. | 4.44 | 0.73 | Highest |
| 6. | An evaluation model of mathematics teacher competency identified data and information sources with clear data origins. | 4.78 | 0.44 | Highest |
| 7. | Tools were developed; data collection was used to evaluate mathematics teacher competency validly. | 4.56 | 0.53 | Highest |
| 8. | Tools were developed; data collection for evaluating mathematics teacher competency was reliable. | 4.67 | 0.71 | Highest |
| 9. | An evaluation model of mathematics teacher competency was a systematic evaluation. | 4.56 | 0.53 | Highest |
| 10. | Reports on the evaluation results of mathematics teacher competency in the lower secondary school were objective. | 4.63 | 0.50 | Highest |

Table 3.5 (continued)

| Item Evaluated | $\mu$ | $\sigma$ | Level |
|---|---|---|---|
| 11. An evaluation model of mathematics teacher competency enabled mathematics to receive information that sufficiently covered decision making and enhancing and developing mathematics teacher competency. | 4.56 | 0.73 | Highest |
| **Overall** | **4.64** | **0.50** | **Highest** |

According to Table 3.5, the quality evaluation in an aspect of accuracy standard in an overall aspect was at the highest level with a mean of 4.64 and standard deviation of 0.05. When considering each particular item, it was found that most of them possessed a mean at a level of high to the highest with a mean between 4.44-4.78. "An evaluation model of mathematics teacher competency identified data and information sources with clear data origins" possessed the highest average of 4.78.

**2. The evaluation results of propriety of an evaluation manual of mathematics teacher competency in the lower secondary school**

The inquiry results from nine connoisseurs consisting of school administrators specializing in teaching mathematics, mathematics educational supervisors, university instructors teaching students majoring in mathematics, curriculum and mathematics teaching connoisseurs, and connoisseurs specializing in educational measurement and evaluation were considered for the propriety of an evaluation model of mathematics teacher competency in the lower secondary school.

Table 3.6 Mean, Standard Deviation, and the Opinion Level of the Connoisseurs toward the Quality of a Manual in Applying an Evaluation Model of Mathematics Teacher Competency in the Lower Secondary Level

| Item Evaluated | $\mu$ | $\sigma$ | Level |
|---|---|---|---|
| 1. According to the goals of evaluating mathematics teacher competency in the lower secondary school, the elements mentioned in the evaluation manual were clear. | 4.33 | 0.71 | High |
| 2. The steps of evaluating mathematics teacher competency in the lower secondary school were clear. | 4.22 | 0.67 | High |
| 3. The evaluation steps were proper and practical to be used in evaluating actual situations. | 4.00 | 0.71 | High |
| 4. The analysis of evaluation results was apparent. | 4.33 | 0.87 | High |
| 5. The evaluating criteria of mathematics teacher competency in the lower secondary school wereclear. | 4.33 | 0.71 | High |
| 6. The judging criteria of the evaluation results were clear. | 4.44 | 0.73 | High |
| 7. The evaluating tools were clear. | 4.33 | 0.50 | High |
| 8. The evaluating tools were simple and practically convenient. | 4.44 | 0.88 | High |
| 9. The reporting of evaluation results was clear. | 4.78 | 0.44 | Highest |
| 10. The reporting of evaluation results was clear. | 4.78 | 0.44 | Highest |
| 11. The information gained from the report of evaluation results was useful in applying as guidelines in enhancing and developing mathematics teacher competency. | 4.56 | 0.73 | Highest |
| 12. The information gained from the report was sufficient. | 4.44 | 0.73 | High |
| 13. The format of the manual in evaluating competency was proper and sufficient. | 4.56 | 0.53 | Highest |
| 14. The content of the manual in evaluating competency was proper and sufficient. | 4.58 | 0.73 | Highest |
| 15. The evaluation examples was clear and practical in applying for evaluation. | 4.67 | 0.71 | Highest |
| 16. The steps of reporting the evaluation results was sufficiently inclusive. | 4.44 | 0.53 | High |
| **Overall** | **4.44** | **0.68** | **High** |

According to Table 3.6, the overall consideration results of the quality of a manual of an evaluation model of mathematics teacher competency in the lower secondary school were at a high level with an average of 4.44 and standard deviation of 0.68. When

considering each item, it was found that the average of quality level ranged from high to highest levels with an average between 4.00 and 4.78. The items which were at the first three highest level were "The reporting of evaluation results was clear," "The evaluation examples was clear and practical in applying for evaluation," and "The content of the manual in evaluating competency was proper and sufficient" with an average of 4.78, 4.67, and 4.58, respectively.

### 3.3 An application result study on an evaluation model of the mathematics teacher competency in the lower secondary schools

In order to examine the quality of an evaluation model of the mathematics teacher competency in the lower secondary school, the research operation was determined in steps as detailed below.

#### 3.3.1 The trying-out of an evaluation model of the mathematics teacher competency in the lower secondary school

The objective of trying out an evaluation model of the mathematics teacher competency in the lower secondary schools under the Office of Basic Education Commission was to study the quality of model, strengths, weaknesses, problems, obstacles of the model, and an evaluation model application manual. The operation was listed as follows.

1. Planning on trying out an evaluation model

1.1 Survey and select the educational institutions that were interested in participating in this research willingly. These were six schools in total which were three schools under the Office of Primary Educational Service Area, one moderate secondary school under the Office of Secondary Educational Service Area, Chiang Mai, and two big schools under the Office of Secondary Educational Service Area, Chiang Mai.

1.2 Survey mathematics teacher information in each educational institution and acquire three mathematics teachers in the Office of Primary Educational Service Area and seven mathematics teachers in moderate and big schools under the Office of the Secondary Educational Service Area, Chiang Mai.

2. Coordinate, ask for assistance in trying out an evaluation model of the mathematics teacher competency by writing a letter addressing to directors of the

educational institutions in order to ask for cooperation in trying out the evaluation model, and select ten teachers who willingly participated in the research from these six schools.

3. The researcher sent letters to the directors of the educational institutions in person in order to inform reasons, necessities, research steps, and a calendar of trying out the evaluation model.

4. Coordinate with the educational institutions to determine and appoint a teacher competency evaluating board which consisted of evaluating committee president, vice committee president, evaluating committee members, and a secretary.

5. Prepare for trying out an evaluation model by holding a meeting to clarify evaluation details to evaluating committee members. These consisted of an evaluation model application manual so that sample groups could study and comprehend a structure, elements, and key content of the evaluation model.

6. The evaluating committee members on teacher competency operated competency evaluation with suggestions and assistance from the researcher. During the trying out of the evaluation model of mathematics teacher competency, the evaluation results of the evaluation model on competency, the Rater Agreement Index (RAI), and the evaluation results of mathematics teacher competency individually in an overall picture.

7. Analyze the results of trying out the evaluation model of competency. The researcher analyzed the evaluation results of teacher competency together with the secretary of the evaluating committee in each school so as to acknowledge scores of teacher competency evaluation and a competency level. This would be conducted confidentially.

8. Analyze the Rater Agreement Index (RAI) which was an indicator of the agreement level of the scores gained from the evaluation of two or more raters. If the calculated value was close to 1, it expressed that the raters gave scores harmoniously (Burry-Stock: 1996).

9. After processing the evaluation results, the trying-out results of an evaluation model of the teacher competency were summarized and reported in an overall picture to the mathematics teachers, their peers, and school administrators in order for them to evaluate the evaluation model of the mathematics teacher competency.

10. Adopt the information gained from trying out the evaluation model to adjust and develop the evaluation model so that it was more complete.

**Research tools:**

The research tool used to collect data for evaluating an evaluation model of the mathematics teacher competency in the lower secondary school was a record form of the evaluation results on mathematics teacher competency in the lower secondary school which was an experiment group. It was a record form summarizing scores of knowledge in mathematics content, skills in managing mathematics learning, and psychological factors in developing students, virtue, morality, and professional ethics.

**Data analysis:**

1. The evaluation result analysis in order to examine concurrent validity of the evaluation model by means of known group technique of competency scores between two teacher groups and testing statistics of Mann-Whitney U test.

2. Analyze the Rater Agreement Index (RAI).

3. Analyze data from a questionnaire on opinions toward an evaluation model and an application manual of an evaluation model of the mathematics teacher competency in the lower secondary school by calculating of mean and standard deviation of opinion scores. The average interpretation criteria (Boonchom Srisa-ard: 2010) was as follows.

The average of 4.51 – 5.00 was “an extreme level of opinions.”
The average of 3.51 – 4.50 was “a considerable level of opinions.”
The average of 2.51 – 3.50 was “a moderate level of opinions.”
The average of 1.50 – 2.50 was “an insignificant level of opinions.”
The average of 1.00 – 1.50 was “a least level of opinions.”

**Sample groups:**

1. An experimental group in order to identify concurrent validity of the evaluating tools on mathematics teacher competency in terms of learning management skills and psychological factors in developing student virtue, morality, and professional ethnics consisted of 34 mathematics teachers in the lower secondary schools under the

Office of Primary Educational Service Area I and the Office of Secondary Educational Service Area 34, Chiang Mai.

2. A fundamental field experimental group consisted of two mathematics teachers in the lower secondary schools under the Office of the Basic Education Commission in Chiang Mai, the Primary Educational Service Area, and the Office of Secondary Educational Service Area, 76 students taught by the mathematics teachers, and four administrators and mathematics teacher peers selected as a sample group. They were selected by a purposive sampling method from the schools that their administrators, teacher peers, and mathematics teachers were pleased to participate in the research in order to consider, examine definition convey of tool language based on the evaluation model, and study mathematics teachers' behaviors, those relevant with the evaluation, clarity of clarifying the evaluation model, and a proper time frame of the evaluation in each competency of the experimental results.

3. A major field testing group consisted of three mathematics teachers in the lower secondary schools under the Primary Educational Service Area and the Office of Secondary Educational Service Area in Chiang Mai, 78 students selected by the mathematics teachers as a sample group, and six administrators and mathematics teacher peers selected as a sample group. They were selected by a purposive sampling method from the schools that their administrators, teacher peers, and mathematics teachers were pleased to participate in the research in order to identify the drawbacks of applying the evaluation model as guidelines of adjusting and correcting.

4. An experimental group of evaluating the model quality consisted of five mathematics teachers in the lower secondary schools under the Primary Educational Service Area and the Office of Secondary Educational Service Area in Chiang Mai, 178 students selected by the mathematics teachers as a sample group, and five administrators and mathematics teacher peers selected as a sample group. They were selected by a purposive sampling method from the schools that their administrators, teacher peers, and mathematics teachers were pleased to participate in the research.



**3.3.2 The examination results of concurrent validity on the evaluation results of mathematics teacher competency in the lower secondary school**

In the step of trying out the tools in evaluating mathematics teacher competency regarding learning management skills and psychological factors in developing students, virtue, morality, and professional ethics, the concurrent validity was examined by a known group technique. The researcher tried out the evaluation model with 34 mathematics teachers in schools under the Office of Primary Educational Service Area I and the Secondary Educational Service Area 34, Chiang Mai. The teachers were grouped into two groups. The former was a high group (who was accepted as having trend of knowledge and ability in content, teaching methods and skills, and operational dedication at a high level. This could be considered from social dimension data, inquiring students, teacher peers and administrators, content group heads, holding academic standing or awards given by other offices which identified that they possessed knowledge, ability, and operational dedication at a high level.) The latter was a low group (who tended to operate in educational institutions ordinarily without holding academic standing or awards given by other offices which identified that they possess knowledge, ability, and ordinarily operational dedication. The evaluation results were conducted randomly in a group of six teachers in order to consider concurrent validity of evaluating teacher competency that referred to competency of a high group and a low group which was different in terms of statistical significance.

Table 3.7 The Analysis Results of Indicators on Mathematics Teacher Competency in the Lower Secondary School between a High and a Low Groups in terms of Competency in Mathematics Learning Managing Skills

| Indicators | Group 1 | | Group 2 | | U | p |
|---|---|---|---|---|---|---|
| | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | | |
| 1. Produce, provide, develop, and use mathematics learning innovation media that was in accordance with subject content and indicators. | 8.67 | 52.00 | 4.33 | 26.00 | 5.00 | 0.041* |
| 2. Be able to use various mathematics teaching methods. | 8.67 | 52.00 | 4.33 | 26.00 | 5.00 | 0.041* |
| 3. Be able to use various teaching techniques. | 8.83 | 53.00 | 4.17 | 25.00 | 4.00 | 0.026* |
| 4. Be able to use mathematics teaching concepts accurately and properly. | 9.00 | 54.00 | 4.00 | 24.00 | 3.00 | 0.015* |

Table 3.7 (continued)

| Indicators | Group 1 | | Group 2 | | U | p |
|---|---|---|---|---|---|---|
| | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | | |
| 5. Be able to use various concepts and methods of measuring and evaluating results in measuring and evaluating students' mathematics results. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009* |
| 6. Be able to construct and use various tools in students' learning authentically and systematically in accordance with standards, indicators, learning content, and expected achievement. | 8.92 | 53.50 | 4.08 | 24.50 | 3.50 | 0.015* |
| 7. Contain techniques and methods of teachers' questioning to stimulate students so that they could exhibit conceptualized thoughts regarding mathematics knowledge by themselves. | 9.50 | 57.00 | 3.50 | 21.00 | 0.00 | 0.002* |
| 8. Provide learning activities on mathematics enhancing students' mathematics learning development. | 9.00 | 54.00 | 4.00 | 24.00 | 3.00 | 0.015* |
| 9. Be able to provide learning activities cultivating good attitude toward mathematics among students continuously. | 9.50 | 57.00 | 3.50 | 21.00 | 0.00 | 0.002* |
| 10. Analyze the evaluation results on students' learning and adopt those results to adjust and develop their learning in studying mathematics. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009* |
| 11. Manage mathematics learning so that students possessed connective thoughts on mathematics and other sciences. | 8.83 | 53.00 | 4.17 | 25.00 | 4.00 | 0.026* |
| 12. Manage integrative learning so that students could learn for thinking analytically, criticizing, and solving problems. | 8.83 | 53.00 | 4.17 | 25.00 | 4.00 | 0.026* |

Table 3.7 (continued)

| Indicators | Group 1 | | Group 2 | | U | p |
|---|---|---|---|---|---|---|
| | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | | |
| 13. Manage mathematics learning to students so that they could learn reasonably and know how to question themselves in order to get answers needed. | 8.92 | 53.50 | 4.08 | 24.50 | 3.50 | 0.015* |
| 14. Provide learning activities in order to practice key fundamental skills, especially those regarding calculation to use as a tool for furthering their education. | 8.92 | 53.50 | 4.08 | 24.50 | 3.50 | 0.015* |

*statistically significant at a level of .05

According to Table 3.7, it was found that the indicators of mathematics teacher competency in the lower secondary schools under the Office of the Basic Education between a high and a low groups in terms of competency in mathematics learning management skills varied statistically significantly at a level of .05 in every indicator.

Table 3.8 The Analysis Results of Indicators on Mathematics Teacher Competency in the Lower Secondary School between a High and a Low Groups in terms of Competency in Students Problem Solving and Self-Development Skills

| Indicators | Group 1 | | Group 2 | | U | p |
|---|---|---|---|---|---|---|
| | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | | |
| 1. Contain research for developing mathematics learning activity management. | 8.83 | 53.00 | 4.17 | 25.00 | 4.00 | 0.026 |
| 2. Employ community learning sources and local wisdom as media to preparing mathematics learning. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009 |
| 3. Contain academic work, such as articles, media, projects, research, or other academic works relevant to mathematics dissemination. | 8.92 | 53.50 | 4.08 | 24.50 | 3.50 | 0.015 |

Table 3.8 (continued)

| Indicators | Group 1 | | Group 2 | | U | p |
|---|---|---|---|---|---|---|
| | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | | |
| 4. Prepare learning activities enhancing thinking procedure in mathematics by themselves by exercises. | 9.42 | 56.50 | 3.58 | 21.50 | 0.50 | 0.002 |
| 5. Prepare learning activities enhancing the pursuit of self-knowledge, such as mathematics projects and independent studies. | 8.67 | 52.00 | 4.33 | 26.00 | 5.00 | 0.041 |

*statistically significant at a level of .05

According to Table 3.8, it was found that the indicators of mathematics teacher competency in the lower secondary schools under the Office of the Basic Education between a high and a low groups in terms of competency in student problem solving and self-development skills varied statistically significantly at a level of .05 in every indicator.

Table 3.9 The Analysis Results of Indicators on Mathematics Teacher Competency in the Lower Secondary School between a High and a Low Groups in terms of Competency in Student Development Skillsin Mathematics Learning

| Indicators | Group 1 | | Group 2 | | U | p |
|---|---|---|---|---|---|---|
| | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | | |
| 1. Enhance and encourage students in connecting surroundings near them so that they could value mathematics. | 9.50 | 57.00 | 3.50 | 21.00 | 0.00 | 0.002 |
| 2. Possess patience in waiting for answers from students without telling the answers or summarizing before allowing students to think and solve problems by themselves. | 9.50 | 57.00 | 3.50 | 21.00 | 0.00 | 0.002 |
| 3. Enhance students to realize mathematics procedural skills for | 8.83 | 53.00 | 4.17 | 25.00 | 4.00 | 0.026 |

learning happily.

Table 3.9 (continued)

| Indicators | Group 1 | | Group 2 | | U | p |
|---|---|---|---|---|---|---|
| | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | | |
| 4. Employ situations or give examples derived from themselves or others who adopted mathematics thinking into their daily lives. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009 |
| 5. Practice students to be patient and reasonable in using mathematic reasoning in judging problems. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009 |
| 6. Cultivate good attitude toward mathematics to students in teaching and learning mathematics. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009 |

*statistically significant at a level of .05

According to Table 3.9, it was found that the indicators of mathematics teacher competency in the lower secondary schools under the Office of the Basic Education between a high and a low groups in terms of competency in student development skillsin mathematics learning varied statistically significantly at a level of .05 in every indicator.

Table 3.10 The Analysis Results of Indicators on Mathematics Teacher Competency in the Lower Secondary School between a High and a Low Groups in terms of Psychological Factors in Developing Students, Virtue, Morality, and Professional Ethics

| Indicators | Group 1 | | Group 2 | | U | p |
|---|---|---|---|---|---|---|
| | Mean Rank | Sum of Ranks | Mean Rank | Sum of Ranks | | |
| 1. Possess enthusiasm in teaching mathematics. | 8.67 | 52.00 | 4.33 | 26.00 | 5.00 | 0.041 |
| 2. Accept and listen to students' opinions and reasons. | 9.33 | 56.00 | 3.67 | 22.00 | 1.00 | 0.004 |
| 3. Possess effort in developing themselves by attending workshop and searching for additional knowledge regarding teaching and learning mathematics. | 9.00 | 54.00 | 4.00 | 24.00 | 3.00 | 0.015 |
| 4. Be careful and disciplined in working and work systematically. | 9.00 | 54.00 | 4.00 | 24.00 | 3.00 | 0.015 |
| 5. Be responsible in assigned duties or directly relevant tasks. | 8.83 | 53.00 | 4.17 | 25.00 | 4.00 | 0.026 |
| 6. Possess consideration in critically thinking about what was happening or tending to happen. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009 |
| 7. Be mentally strong, reasonable, and careful toward belief or faith. | 9.50 | 57.00 | 3.50 | 21.00 | 0.00 | 0.002 |
| 8. Be justice and possess democratization. | 9.50 | 57.00 | 3.50 | 21.00 | 0.00 | 0.002 |
| 9. Contain love, faith, and pride toward profession and a status of being mathematics teachers. | 9.00 | 54.00 | 4.00 | 24.00 | 3.00 | 0.015 |
| 10. Keep and collect data records of student learning systematically and use them usefully. | 8.67 | 52.00 | 4.33 | 26.00 | 5.00 | 0.041 |
| 11. Be interested in and determined in enhancing and developing students to be genius in mathematics. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009 |
| 12. Enhance students to think for various methods in solving problems and give them a chance to select theirs. | 9.17 | 55.00 | 3.83 | 23.00 | 2.00 | 0.009 |

*statistically significant at a level of .05

According to Table 3.10, it was found that the indicators of mathematics teacher competency in the lower secondary schools under the Office of the Basic Education between a high and a low groups in terms of competency in psychological factors in developing students, virtue, morality, and professional ethics varied statistically significantly at a level of .05 in every indicator.

### 3.3.3 The results of trying out the evaluation model of mathematics teacher competency in a fundamental field experimental group

Table 3.11 The Results of Two Mathematics Teacher Competency Evaluation in a Fundamental Field Experimental Group

| Competency Elements | Total Scores | Teacher A | | | Teacher B | | |
|---|---|---|---|---|---|---|---|
| | | Scores Earned | Percentage | Quality Level | Scores | Percentage | Quality Level |
| 1. Competency of mathematics content knowledge | | | | | | | |
| 1.1 Six content groups of mathematics content knowledge | **15** | 12.25 | 81.67 | Good | 9.50 | 63.63 | Fair |
| 1.2 Mathematics content teaching method knowledge | **15** | 9.00 | 60.00 | Fair | 8.25 | 55.50 | Improve |
| 1.3 Mathematics curriculum goal knowledge | **5** | 2.75 | 55.00 | Good | 3.25 | 65.00 | Fair |
| 1.4 Curriculum application and preparation knowledge | **15** | 8.25 | 55.00 | Good | 6.50 | 43.33 | Improve |
| **Total** | **50** | **32.25** | **64.25** | **Fair** | **27.50** | **55.50** | **Improve** |
| 2. Learning management skill competency | | | | | | | |
| 2.1 Mathematics learning management skills | **17** | 14.35 | 84.41 | Good | 14.79 | 87.00 | Improve |
| 2.2 Self-development and student problem-solving skills | **5** | 3.65 | 73.00 | Fair | 4.35 | 64.40 | Fair |
| 2.3 Student development | **8** | 7.12 | 89.00 | Good | 6.16 | 67.75 | Fair |
| **Total** | **30** | **25.12** | **83.73** | **Good** | **25.3** | **61.23** | **Fair** |
| 3. Psychological factors in developing students, virtue, morality, and professional ethics | **20** | 17.25 | 86.25 | Good | 16.45 | 82.25 | Good |
| **Total** | **100** | **74.62** | | **Fair** | **62.32** | | **Fair** |

According to Table 3.11 showing competency evaluation results of two mathematics teachers in a fundamental field experimental group, the competency evaluation results were at a fair level.

### 3.3.4 The results of trying out the evaluation model of mathematics teacher competency in a major field experimental group

Table 3.12 The Results of Three Mathematics Teacher Competency Evaluation in a Major Field Experimental Group

| Competency Elements | Total Scores | Teacher C | | | Teacher D | | | Teacher E | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Scores Earned | Percentage | Quality Level | Scores | Percentage | Quality Level | Scores | Percentage | Quality Level |
| 1. Competency of mathematics content knowledge | | | | | | | | | | |
| 1.1 6 content groups of mathematics knowledge | **15** | 8.75 | 58.33 | Improve | 11.50 | 76.67 | Fair | 12.00 | 80.00 | Good |
| 1.2 Math content teaching method knowledge | **15** | 5.50 | 36.66 | Improve | 6.25 | 41.67 | Improve | 7.00 | 46.67 | Improve |
| 1.3 Mathematics curriculum goal knowledge | **5** | 3.00 | 60.00 | Fair | 2.50 | 50.00 | Improve | 2.50 | 50.00 | Improve |
| 1.4 Curriculum application/preparation knowledge | **15** | 6.75 | 45.00 | Improve | 7.50 | 50.00 | Improve | 7.00 | 46.67 | Improve |
| **Total** | **50** | **24** | **48.00** | **Improve** | **27.75** | **55.50** | **Improve** | **28.50** | **57.00** | **Improve** |
| 2. Learning management skill competency | | | | | | | | | | |
| 2.1 Mathematics learning management skills | **17** | 9.75 | 57.35 | Improve | 13.58 | 79.88 | Fair | 14.75 | 86.76 | Good |
| 2.2 Self-development/problem-solving skills | **5** | 3.34 | 66.80 | Improve | 3.85 | 77.00 | Fair | 4.12 | 82.40 | Good |
| 2.3 Student development | **8** | 6.14 | 76.75 | Fair | 7.12 | 89.00 | Good | 6.92 | 86.50 | Good |
| **Total** | **30** | **19.23** | **64.10** | **Fair** | **24.55** | **81.83** | **Good** | **25.75** | **85.96** | **Good** |
| 3. Psychological factors in developing students, virtue, morality, and professional ethics | **20** | 18.35 | 91.75 | Good | 17.54 | 87.70 | Good | 18.27 | 91.35 | Good |
| **Total** | **100** | **61.58** | | **Fair** | **69.84** | | **Fair** | **72.52** | | **Fair** |

According to Table 3.12 showing competency evaluation results of three mathematics teachers in a major field experimental group, the competency evaluation results in an overall picture were at a fair level.

### 3.3.5 The quality evaluation of the evaluation model toward mathematics teacher competency in the lower secondary school

The objective of this evaluation was to study and evaluate the evaluation model of mathematics teacher competency in the lower secondary school so as to consider whether the evaluation model was feasible, appropriate, accurate, and useful when applied to evaluate mathematics teacher competency in the lower secondary school. The evaluation results of mathematics teacher competency of each individual, the Rater Agreement Index, and the evaluation model of mathematics teacher competency were considered.

**Target groups:**

The experimental groups in evaluating model quality were five mathematics teachers in the lower secondary schools under the Primary Educational Service Area and the Office of Secondary Educational Service Area in Chiang Mai, 178 students selected by the mathematics teachers as a sample group, and ten administrators and mathematics teacher peers selected as a sample group. They were selected by a purposive sampling method from the schools that their administrators, teacher peers, and mathematics teachers were pleased to participate in the research.

**Research tools:**

A quality evaluation form of the evaluation model of mathematics teacher competency in the lower secondary schools for connoisseurs, assessors, and those assessed was in a format of a 5-point rating scale. The scoring criteria was determined as follows.



"5" meant "an evaluation model was appropriate in terms of utility, feasibility, moral propriety, and accuracy as reported in that evaluating item at the extreme level."

"4" meant "an evaluation model was appropriate in terms of utility, feasibility, moral propriety, and accuracy as reported in that evaluating item at the considerable level."

"3" meant "an evaluation model was appropriate in terms of utility, feasibility, moral propriety, and accuracy as reported in that evaluating item at the moderate level."

"2" meant "an evaluation model was appropriate in terms of utility, feasibility, moral propriety, and accuracy as reported in that evaluating item at the insignificant level."

"1" meant "an evaluation model was appropriate in terms of utility, feasibility, moral propriety, and accuracy as reported in that evaluating item at the least level."

**Data collection:**

1. Inform and enhance understanding toward objectives, operational steps, those relevant to teacher competency evaluation, namely school administrators, teachers, teacher peers, and students. Make an appointment to evaluate teacher competency.

2. Try out the evaluation model of evaluating mathematics teacher competency in various forms with five mathematics teachers and record the evaluation results.

3. Identify the Rater Agreement Index (RAI)

4. Allow mathematics teachers, administrators, and teacher peers to evaluate the quality of the evaluation model of mathematics teacher competency.

**Data analysis methods and employed statistics:**

1. Analyze mean, standard deviation, and opinions of those relevant to the evaluation model. Then, compare with the criteria which was not lower than 3.51.

The interpretation of the mean was as follows.

Opinions at a level of 4.51 – 5.00 referred to "an evaluation model was appropriate at the extreme level."

Opinions at a level of 3.51 – 3.50 referred to "an evaluation model was appropriate at the considerate level."

Opinions at a level of 2.51 – 2.50 referred to "an evaluation model was appropriate at the moderate level."

Opinions at a level of 1.51 – 2.50 referred to "an evaluation model was appropriate at the insignificant level."

Opinions at a level of 1.00 – 1.50 referred to "an evaluation model was appropriate at the least level."

2. Express opinions toward the application of content analysis model.

3. Analyze the Rater Agreement Index (RAI) by considering the evaluation result. If it approached "1," this exhibited that the assessors contained the harmonious evaluation results (Burry Stock: 1993)

4. Analyze the evaluation results of the mathematics teacher competency by means of an average and percentage.

**3.4 Identification of guidelines to develop and enhance the mathematics teacher competency in the lower secondary schools**

**3.4.1 Identification of guidelines to develop and enhance the mathematics teacher competency**

**A sample groups:**

A sample group used to identify guidelines to develop and enhance mathematics teacher competency was 653 mathematics teacher in schools throughout the country under the Office of Basic Education Commission.

**Research tools:**

A record form of identifying guidelines to develop and enhance mathematics teacher competency in the lower secondary school was used as a research tool. This form was an open-ended questionnaire in order to inquire guidelines of developing and enhancing mathematics teacher competency in the lower secondary school.



**Operational methods used to construct a questionnaire in order to identify guidelines to develop and enhance mathematics teacher competency in the lower secondary school:**

The operation to construct the questionnaire wasconducted as follows.

1. Study documents and research regarding guidelines for developing and enhancing teacher competency in order to construct question items for connoisseurs and

question issues covering mathematics teacher competency in the lower secondary school in the three core competency aspects.

2. Adopt the tool to examine accuracy and clarity, adjust, and correct.

3. Propose to three connoisseurs so as to examine its content coverage, language appropriateness, and additional recommendations regarding guidelines of developing mathematics teacher competency and evaluation model elements.

4. Analyze proposed issues to examine results so as to be the guidelines to develop mathematics teacher competency.

**Data collection:**

As for data collection to identify guidelines to develop and enhance mathematics teacher competency in the lower secondary school, the researcher sent the questionnaire to assessors in person so that they expressed opinions toward the guidelines to develop and enhance mathematics teacher competency in the lower secondary school and asked them to return it by post.

**Data analysis methods:**

The content analysis was employed to identify guidelines of developing mathematics teacher competency.

**3.4.2 Evaluation of appropriate guidelines toward the guidelines to develop and enhance mathematics teacher competency in the lower secondary school**

**Target groups:**

The target groups consisted of a total 68 people which were 34 mathematics teachers in the lower secondary school who experienced in teaching mathematics at least 10 years or held an academic standing higher than a specialist, 7 educational supervisors in mathematics, and 17 mathematics instructors in higher education collected by a purposive sampling method.

**Research tools:**

A questionnaire on guidelines to develop and enhance mathematics teacher competency in the lower secondary school was used as a research tool. It was formed in a check-list pattern and a rating scale inquiring three aspects which were the guidelines to develop

and enhance mathematics teacher competency in terms of mathematics content knowledge, knowledge regarding curriculum and its application, learning management skills, and psychological factors of developing students, virtue, morality, and professional ethics.

**A questionnaire sample on guidelines to develop and enhance mathematics teacher competency:**

According to your opinions, the guidelines to develop and enhance mathematics teacher competency in the lower secondary school in terms of mathematics content knowledge as shown in the following guidelines were necessary and appropriate to be used as guidelines to develop and enhance mathematics teacher competency at which level.

Table 3.13 A Questionnaire Sample

| **Guidelines to develop competency** | **Necessity and appropriateness of the guidelines to develop competency** | | | | | **Recommendations** |
|---|---|---|---|---|---|---|
| | **5** | **4** | **3** | **2** | **1** | |
| 4. Training methods | | | | | | |
| 1.1 Guest speaker-centered training | | | | | | |
| 1) Lecture | | | | | | |
| 2) Group discussion | | | | | | |
| 3) …… | | | | | | |
| 1.2 Participant-centered training | | | | | | |
| 1) Panel meeting | | | | | | |
| 2) Seminar | | | | | | |
| 3) …… | | | | | | |

**Operational methods to construct a questionnaire on guidelines to develop and enhance mathematics teacher competency:**

1. Adopt the data gained from Step 1 to construct a questionnaire for connoisseurs regarding necessities and appropriateness of guidelines to develop and enhance mathematics teacher competency and question issues covering mathematics teacher competency in the lower secondary school in three core competency aspects.

2. Propose the tool to the dissertation advisor, adjust, and correct as recommended.

3. Propose to three connoisseurs for inspecting content coverage, appropriateness, and language clarity of the guidelines to develop and enhance mathematics teacher competency so as to correct as appropriate and be used to collect data.

**Data collection:**

In terms of data collection in order to identify the guidelines to develop and enhance mathematics teacher competency, it was conducted as follows.

1. Contact and coordinate the connoisseurs to ask for their cooperation in corresponding, send the questionnaire to the connoisseurs, and ask them to send back to the researcher by post.

2. Examine the accuracy of the returned questionnaire so as to analyze data.

**Data analysis methods:**

The data analysis was conducted by a consideration of median and the difference between the first and third quartile (Q3-Q1) on a basis of the following criteria.

1. Median exhibited possibility of trends as determined by the following criteria (Glass: 1970).

| | |
|---|---|
| More than 4.50 | referred to "a guideline or method that tends to extremely happen." |
| 3.50 – 4.49 | referred to "a guideline or method that tends to highly happen." |
| 2.50 – 3.49 | referred to "a guideline or method that tends to moderately happen." |
| 1.50 – 2.49 | referred to "a guideline or method that tends to slightly happen." |
| Less than 1.50 | referred to "a guideline or method that tends to least happen." |

2. Interquartile range (Q3-Q1) exhibited harmonious opinions of the connoisseurs as follows.

| | |
|---|---|
| Less than or equal to 1.50 | referred to "the harmonious opinions among the connoisseurs." |
| More than 1.50 | referred to "the unharmonious opinions among the connoisseurs." |