CHAPTER 5

Summary, Conclusions, and Recommendations

This research was considered a research and development with four research objectives which were (1) to analyze the elements and indicators in evaluating mathematics teacher competency in the lower secondary school, (2) to construct a model and a manual on evaluating mathematics teacher competency in the lower secondary school, (3) to study the application results of the evaluation model of mathematics teacher competency in the lower secondary school, and (4) to identify guidelines of developing and enhancing mathematics teacher competency in the lower secondary school.

5.1 Summary of Study Results

The research methodology consisted of four steps as follows. Step 1 was the analysis of elements and indicators of mathematics teacher competency in the lower secondary schools. Step 2 was the construction and development of a model of mathematics teacher competency in the lower secondary schools. Step 3 was the study results of the evaluation model application of mathematics teacher competency in the lower secondary schools. Step 4 was the identification of guidelines to develop and enhance competencyof mathematics teacher competency in the lower secondary schools.

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Step 1:

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

A sample group consisted of connoisseurs on curriculum and mathematics teaching methods, educational supervisors in mathematics, connoisseurs on measuring and assessing, and administrators in the lower schools holding an academic holding higher than specializes. This was a group of 17 connoisseurs selected by purposive sampling method. Moreover, 633 mathematics teachers in the lower secondary schools under the

Office of the Basic Education Commission were selected by means of multi-stagerandom sampling method. There were three forms which were considered the tools used to collect data. These were (1) a record form used to synthesize elements and indicators of mathematics teacher competency, (2) a questionnaire on indicator propriety, and (3) a questionnaire on importance and necessity of the indicators. The reliability value was .853 and the IOC value between 0.80 and 1.00 analyzed by the tools. The data were analyzed by means of content analysis, mean, standard deviation, and exploratory factor analysis.

Step 2:

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

There were four target groups which were (1) a group considering concurrent validity. Three copies of a knowledge test on mathematics content in the secondary level were provided for mathematics teachers in the lower secondary schools, mathematics educational supervisors, connoisseurs in measuring and evaluating, and connoisseurs in curriculum and mathematics teaching. The connoisseurs considered separating the tools so that the number was not too many. The total number of this group members was 92 who were selected by a purposive sampling method. The second target group was (2)an experimental group in order to use a test to measure knowledge in mathematics content, a learning management skill evaluation form, and a competency evaluation form on psychological characteristics in developing students, virtue, morality, and professional ethics. They were 34 mathematics teachers in the lower secondary schools and in the secondary schools under the Primary Educational Service Area 1 and the Office of Secondary Educational Service Area, Chiang Mai Province, respectively. They were selected by means of a purposive sampling method. And, (3) a group of connoisseurs in considering accuracy and propriety of the evaluation model of mathematics teacher competency by means of a focus group. They were mathematics teachers hold academic standing higher than specialists, mathematics educational supervisors, connoisseurs in curriculum and mathematics teaching methods, connoisseurs in measuring and evaluating, and school administrators whose fundamental knowledge and experience was in mathematics teaching and learning in the secondary level in a

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total of 11 people. And, another nine connoisseurs in evaluating an evaluation model of mathematics teacher competency were also selected. All of them were selected by means of a purposive sampling method. The tools used were (1) three copies of a knowledge test on mathematics content in the lower secondary level. Their IOC value was between 0.80 and 1.00 with a reliability value at 0.72, 0.75, and 0.77, respectively. (2) Three copies of a competency evaluation form of mathematics teacher competency in learning management skills and (3) a competency evaluation form on psychological aspects in developing students, virtue, morality, and professional ethics were analyzed for an IOC value which was between 0.80 – 1.00 with a reliability value at 0.92, 0.81, 0.83, and 0.88, respectively. (4) A questionnaire for evaluating an evaluation model of competency and a questionnaire for evaluating an evaluation manual of teacher competency possessed an IOC value between 0.80 – 1.00 in every item evaluated. The research methodology was the trying-out of testing a test in measuring mathematics content knowledge. Then, a competency evaluation form was tried out with mathematics teachers in terms of learning management skills. The competency evaluation form regarding psychological aspects in developing students was analyzed in terms of the difficulty level, reliability, discrimination power, and content validity to identify mean and standard deviation and compare with the criteria. In terms of the recommendation in evaluating, the content analysis, an evaluation form of learning management skills, and an evaluation form of psychological aspects in developing students were identified for their concurrent validity and accordance of assessors.

Step 3:

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

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There were three sample groups which were (1) a fundamental field experimental group consisting of two mathematics teachers in the lower secondary schools under the Primary Educational Service Area, and the Office of Secondary Educational Service Area, 71 students taught by the mathematics teachers, and four administrators and mathematics teacher peers. They were selected by a purposive sampling method.(2) 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, 138 students taught by the mathematics teachers, and six administrators and mathematics teacher peers. They were selected by a purposive sampling method. And, (3) 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, 143 students taught by the mathematics teachers, and ten administrators and mathematics teacher peers. They were selected by a purposive sampling method. The tools consisted of an evaluation form toward propriety of the evaluation model and an evaluation form toward an evaluation manual. The IOC value was analyzed and found between 0.80 and 1.00. They were considered by the connoisseurs in terms of accuracy, inclusion, and language propriety. The research methodology was the trying out of the evaluation model in an experimental group in order to evaluation the model quality. The data were analyzed by means of mean and standard deviation in comparison with criteria while the recommendations were used in the content analysis.

Step 4:

The guideline identification to develop and enhance the mathematics teacher competency in the lower secondary schools

92 informants of this step were the connoisseurs in teaching mathematics, school administrators, educational supervisors, and mathematics teachers in the lower secondary schools. They were selected by a purposive sampling method. The research tools were (1) a questionnaire on needs and guidelines in developing and enhancing mathematics teacher competency in the lower secondary schools and (2) a questionnaire on guidelines in developing and enhancing mathematics teacher competency. They were considered by the connoisseurs in terms of accuracy, inclusion, and language propriety. The data were collected via the questionnaires regarding the guidelines in developing and enhancing mathematics teacher competency sent by the researcher to the connoisseurs. The data were then summarized as the guidelines in developing and enhancing mathematics teacher competency and analyzed by means of median, the value of the interquartile range (Q3-Q1), and the content analysis.

5.2 Conclusion of the Study Results

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1. The results of an analysis of elements and indicators of mathematics teacher competency in the lower secondary schools

It was found that the mathematics teacher competency in the lower secondary schools possessed necessary competency in 63 indicators. These indicators could pass the evaluation criteria, the Rater Agreement Index (RAI), of the connoisseurs at a level higher than 0.8 completely in term of theory accuracy, accordance with curriculum standards, and possibility in employing to evaluate teacher competency. When analyzed by means of the exploratory factor analysis, it was found that all indicators could be grouped into eight elements which were (1) a knowledge element of mathematics learning content, (2) a knowledge element ofmathematics learning content methods, (3) a knowledge element of curriculum goals, innovative media application, and relevant fundamental knowledge, (4) a knowledge element of curriculum and curriculum application, (5) a skill element of mathematics learning management, (6) a skill element of solving student problems and self-development, (7) a knowledge element of student development, and (8) an element of psychological factors in developing students, virtue, morality, and professional ethics. The variance of all elements could explain the indicators at 66.70 percent. According to the results from examining element quality and the indicators of mathematics teacher competency in the lower secondary schools, it was found that they were in congruence possessing KMO value at .975 reflecting that this set of variables was proper for the factor analysis at a level of excellence as set in Kim and Mueller's criteria (cited in Nongluck Wiratchai: 1999). According to the Bartlett's Test of Sphericity, the test results were statistically significant at a level of .01. This expressed that the correlation of indicators was different from identity matrix statistically significantly. The variables were properly relating for the factor analysis.

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2.Theresults of the construction and development of a model and an application manual of an evaluation model of mathematics teacher competency in the lower secondary schools

It was found that the evaluation model of teacher competency consisted of five elements which were (1) evaluation goals, (2) evaluation scopes, (3) evaluation operation consisting of assessors, evaluating tools, evaluating methods, and an evaluation time period, (4) evaluation result judgment consisting of evaluation criteria and a processing program, and (5) result reporting and evaluation result application. The details of the evaluation model were explained in the evaluation manual of mathematics teacher competency in the lower secondary schools. The results of inspecting the quality of the evaluation model and an evaluation manual were at a high level onward.

3. The results gained from trying out an evaluation model and an evaluation manual of the mathematics teacher competency in the lower secondary schools

3.1 The quality evaluation results of an evaluation model in terms of utility, feasibility, propriety, and accuracy standards in an overall aspect were appropriate at a high level with a mean of 4.38, 4.38, 4.33, and 4.37, respectively. The evaluation results gained from school administrators and teacher peers were appropriate at a high level and the highest level with a mean of 4.41, 4.43, 4.49, and 4.50, respectively.

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3.2 In applying an evaluation model of mathematics teacher competency, the indicators with high factor loading could be selected. The similar elements of a complete evaluation model were used to cover all eight elements by selecting those with high factor loading in the first three to five positions. The indicators were to be considered in terms of their necessity in applying to evaluate and develop mathematics teachers.

4. The results in studying the guidelines to develop and enhance the mathematics teacher competency in the lower secondary schools

4.1 The most appropriate guidelines in developing knowledge of mathematics learning content and mathematics learning content teaching methods were teaching demonstration and brainstorming.

4.2 The most appropriate guidelines in developing skillsin managing mathematics learning were teaching demonstration, workshop, panel discussion, brainstorming, and supervision and monitoring.

4.3 The most appropriate guidelines in developing knowledgeregarding curriculum and curriculum application were the workshop.

4.4 The most appropriate guidelines in developing psychological characteristics in developing students, virtue, morality, and professional ethics were teaching demonstration, brainstorming, and orientation prior to teaching.

5.3 Result Discussion

The development of the evaluation model of mathematics teacher competency in the lower secondary schools was performed as nowadays offices, organizations, professional organizations, and mathematics teaching institutes did not contain any specific indicators, tools, and evaluation guidelines in determining goals and evaluating teacher competency for mathematics and science teacher standards as set by the Institute for the Promotion of Teaching Science and Technology as the guidelines for educational offices. The schools used them only to explore and consider teacher competency without any application in determining the guidelines in developing and enhancing teacher competency. Most mathematics teaching experts agreed that the determined competency as set in the teacher standards did not cover necessary competency of mathematics teachers. According to the aforementioned part, the development of indicators and an evaluation model of mathematics teacher competency in the lower secondary schools was conducted as discussed below.

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5.3.1 The results of analyzing indicators and elements of mathematics teacher competency in the lower secondary schools

5.3.1.1 According to the analysis results of elements and indicators of mathematics teacher competency in the lower secondary schools, it was found that the synthesized competency covered three key competency which were the competency in (1) mathematics content knowledge, (2) mathematics learning management skills, and (3) the psychological characteristics in developing students, virtue, morality, and professional ethics. They also covered the mathematics teacher standards of the Institute for the Promotion of Teaching Science and Technology (IPST: 2002), the Office of Professional Standards, the Office of the Education Council2005), the Office of the Welfare Promotion Commission for Teachers and Education Personnel (2006), the mathematics teacher competency of Umporn Makanong (2014), and the teacher competency of Southeast Asia in the 21st century (2008). The synthesis results also presented that certain competency aspects were additionally or apparently determined. These were the competency of knowledge regarding curriculum goals, innovation media application, relevant fundamental knowledge, and curriculum and its application. As for the skills of student problem-solving, self-development, and student development. These additional competency aspects were partially harmonious with the mathematics teacher competency determined by Shulman (1986) which were curriculum and its application that was in accordance with the synthesis of Thai teacher competency (2008) and mathematics teacher characteristics in the 21st century needed by students. Apart from possessing knowledge in mathematics content and mathematics learning management skills, teachers needed to possess competency in psychological characteristics in developing students (Umporn Makanong: 2014).

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5.3.1.2 According to the results of element analysis, it was found that mathematics teacher competency in the lower secondary schools consisted of eight elements and 63 indicators which covered three core competency of mathematics teachers. According to the results, it was also found that certain elements were determined additionally or more apparently. These were (1) the knowledge competency in mathematics content consisting of four elements which were "mathematics learning content,""mathematics learning content teaching, curriculum, innovative media and

technology application, and fundamental knowledge," and "curriculum and curriculum application."(2) The skill competency of managing mathematics learning consisted of three indicators which were "mathematics learning management process," "student problem-solving and self-development," and "student development in learning mathematics." And, (3) the psychological characteristics in developing students, virtue, morality, and professional ethics were another competency. It was found that these minor competency elements were in accordance with mathematics teacher competency gained from the synthesis of research regarding mathematics teacher competency. According to the indicators gained from studying documents and sources of mathematics teacher competency, the key variables that were harmonious and inclusive with the structure of mathematics teacher competency in the lower secondary schools were gained. When considering the factor loading of the elements, it was found that the highest factor loading lay at mathematics learning content. The second was the knowledge element of mathematics learning content teaching methods which was in accordance with the mathematics teacher standards of the Institute for the Promotion of Teaching Science and Technology (IPST: 2002), the mathematics teacher knowledge of Shulman (1986), Hill, Ball, and Schilling (2004), Hill, Rowan, and Ball (2005), and Umporn Makanong (2014) in that content knowledge was a key and deep concept of all mathematics fields. The knowledge in terms of steps, processes, and the link between these two then positively affected students. The knowledge regarding teaching was considered knowledge and understanding of the teachers in how they could help students to understand mathematics content, including analysis, planning, and content learning management. Problems and issues regarding students' attention and abilities were also different (Magnusson, Krajcik, and Borko: 1999). This was also in accordance with the research synthesis of 23 articles disseminating from 1990 to 2008 regarding mathematics teacher competency. It was found that the mathematics teacher competency that was the most harmonious was the knowledge element in mathematics learning content found in 18 research articles or 64.71 percent (Viroj Thammajinda: 2010). These research findings helped gain the mathematics teacher competency elements that were structural validity. They could be used to evaluate mathematics teacher competency in order to be the data for developing mathematics teacher competency in the lower secondary schools later.

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Within eight competency elements, there were 63 indicators in total. The study results and the discussion of each competency were presented as follows.

1. In terms of a knowledge element of mathematics learning content, it was found that the covariance percentage was 44.84. There were six indicators. When ordering based on the factor loading, the first three indicators were "possess knowledge in geometry in the lower secondary level," "possess knowledge in number and operations in the lower secondary level," and "possess knowledge in measurement in the lower secondary level." This finding was in accordance with that of Kwanjai Sritapak (2012), Sakaorat Jarungnantakan (2013), and the basic education curriculum of the Office of the Basic Education Commission B.E. 2551. When considering knowledge in the first two mathematics content aspects, it was found that geometry content was important as it characterized clear mathematics systems. Learning geometry then could practice in giving reasons rather than believe in luck or guess. Moreover, geometry was fundamental in technology, science, mechanics, light, sound, engineering, design of symbols and mechanism. This relied much on observing relationship in terms of geometrical shapes (Somwong Plengprasopchok: 2008). Knowledge in number and operations needed students to be able to think inclusively regarding number in order to apply in other calculation, such as number operations, addition, subtraction, multiplication, division, and power. Geometry was an important foundation in learning higher mathematics (Ministry of Education: 2008). Teachers had to insert learning activities to students so that they had skills in mathematics processes which were key guidelines that students had to learn in the mathematics curriculum at the lower secondary level. Teunjai Ketsa (1999) also emphasized and proposed teaching elements used to evaluate teachers which were subject content. The six key mathematics content aspects were necessarily fundamental for all students.

2. In terms of a knowledge element of mathematics learning content methods, it was found that the covariance percentage was 6.36. There were six indicators. When ordering based on the factor loading, the first three indicators were "possess knowledge and understanding regarding guidelines in geometry content teaching methods in the lower secondary level," "possess knowledge and understanding regarding guidelines in algebra content teaching methods in the lower secondary level,"

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and “possess knowledge and understanding regarding guidelines in measurement content teaching methods in the lower secondary level.” This was in accordance with the concepts of Magnusson, Krajcik and Borko (1999) in that knowledge and understanding of teachers could help students to understand mathematics content. It was also in harmony with that of Deberg and Greive (1999) who stated that knowledge regarding teaching was a result of changing content into a model helping students to occupy learning. Knowledge regarding teaching dealt with mathematics teaching methods, such as learning management concepts, teaching methods, teaching techniques, media and learning sources, and learning evaluation were to be focused. Somwang Pitiyanuwat et.al. (1994) analyzed proper elements in evaluating operational results of teachers in teaching, and it was found that one of the nine elements supposed to be evaluated was knowledge and ability in teaching methods. Umporn Makanong (2014) stated that knowledge regarding content and teaching was a mixture between mathematics knowledge and teaching, such as knowledge in content and its teaching order, teaching design, example selection, and assignment allowing students to question, and discussion topics.

3. In terms of a knowledge element of curriculum goals, innovative media application, and relevant fundamental knowledge, the covariance percentage was 5.67. There were 4 indicators. When ordering based on the factor loading, the first three indicators were “possess knowledge and understanding in selecting technologies and information technologies in managing mathematics teaching and learning,” “possess knowledge and understanding in innovative media application methods to manage mathematics teaching and learning in the lower secondary level,” and “possess knowledge and understanding in mathematics curriculum goals in the lower secondary level.” This was in accordance with the research findings of Kwanjai Sritapak (2012) and Sakaorat Jarungnantakan (2013). These findings reflected that mathematics teacher competency in the lower secondary schools involved with the teacher ability in using technology to manage learning activities ultimately. According to the National Education Act B.E. 2542 (1999) and Amendments (Second National Education Act B.E. 2545 (2002), teachers were determined to give knowledge in science and technology skills to students in a proper manner to their educational level (the Office for National Education Standards and Quality Assessment: 2004). This was also in

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harmony with the study results of the development direction frame of the National Education Plan (2002-2016) which found that fostering learning so as to create a knowledge body that was proper to Thai society and culture and local wisdom was extremely necessary in managing learning in both formal and informal educational systems (the Office of the Education Council: 2007, 15). In terms of knowledge and understanding regarding curriculum goals and fundamental knowledge in mathematics learning content, these were the indicators identifying mathematics teacher competency. They reflected that teachers possessed knowledge and understanding in a model and methods of managing learning process in a student-centered aspect. The mathematics curriculum and mathematics content were determined as a content structure expressing learning process scopes, plan management, and learning (Patcharee Thongkaew: 2010, 17). Therefore, it was necessary to inspect fundamental knowledge of students which was needed to plan the teaching and learning management. The fundamental knowledge of students in the primary schools would result in their ability in learning mathematics at the secondary level (Department of Curriculum and Instruction Development: 2008, 17). Knowledge and understanding in selecting technology and innovation media application methods in order to manage mathematics learning would increase learning channels which stimulated students to pay attention to the lessons and comprehend them better. It also helped decrease the learning time and gave concrete experience to the students (the Institute for the Promotion of Teaching Science and Technology: 2009, Jakkarin Wannapoklang: 2013, Yupin Piphitkul: 2002, and Pichakorn Plengprasopchok: 1996). In terms of curriculum knowledge, teachers had to know and understand overall aspects and details in order to acknowledge curriculum objectives and needs in that they wanted to develop students in which way, understand, and link the content both at the same level and at the different level (Umporn Makanong: 2013).

4. In terms of a knowledge element of curriculum and curriculum application, the covariance percentage was 2.30. There were 11 indicators. When ordering based on the factor loading, the first three indicators were “possess knowledge of a structural system, concepts, and nature of mathematics,” “possess knowledge of a curriculum structure, standard content, and understanding in mathematics learning content management methods in the lower secondary level,” and “possess knowledge in

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holding mathematics learning activities that were student-centered." This finding was in accordance with that of Inturat Weeradecha (2004), Wassana Sangngam (2009), Adul Wangsrikoon (2000), and Supapan Jaireun (2008) in that mathematics teacher competency was harmonious. The structure of mathematics was abstract, so teachers had to change from abstract to concrete in order to teach students to be able to understand the content. Teachers had to plan their evaluation harmoniously; therefore, they needed to know structures, standard content, and methods to manage learning content so as to select activities that were appropriate to mathematics nature. The student-centered was supposed to be emphasized alongside. Mathematics content standards were analyzed in order to manage mathematics learning which was in accordance with changing social contexts, especially mathematics curriculum that was needed to be integrated mathematics processes into other mathematics knowledge and other sciences (Ministry of Education: 2008, 57). The core curriculum of the basic education in 2008 emphasized that every teacher managed their teaching and learning activities by focusing on the student-centered aspect. Ministry of Education and relevant offices also continuously managed training and teacher development activities so that they possessed skills in manage teaching and learning activities in a student-centered aspect (the Office of the Education Council: 2007, 13)

5. In terms of the skills in mathematics learning management, the covariance percentage was 2.09. There were 11 indicators. When ordering based on the factor loading, the first three indicators were "teachers possessed techniques and methods in asking questions that stimulated students to have mathematics knowledge concepts by themselves," "hold mathematics learning activities enhancing mathematics learning development of students," and "be able to hold learning activities that created good attitude toward mathematics among students continuously." This was in accordance with that of Suwattana Uthairat (2002), Teaching and Learning Standards of the United States (NCTM: 2000), and Panthong Kulnartsiri (2000) in that teachers were supposed to possess questioning strategies in order for students to develop abilities of reasoning, be able to link mathematics concepts with their daily lives. This finding presented that teachers played an important role for students so that they had inclusive thoughts in mathematics content and were able to apply mathematics content to others in their daily lives.

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6. In terms of the skills in solving student problems and self-development, the covariance percentage was 1.92. There were seven indicators. When ordering based on the factor loading, the first three indicators were "possess academic work, such as articles, media, projects, research, or other academic work regarding disseminated mathematics," "employ community learning sources and local wisdom as media to manage mathematics learning," and "hold learning activities enhancing self-knowledge search, such as mathematics projects and independent studies."This was in accordance with the research of Pikul Sonachot (2001) in that mathematics teachers were supposed to be enthusiastic in developing themselves, hard-working, and attentive in teaching mathematics. In terms of academics, teachers were supposed to be well-rounded. Piengjai Jongnok (2004) studied the characteristics based on mathematics teacher standards. It was found that in terms of expressing behaviors teachers were supposed to not only seek a chance in developing their profession by enthusiastically attending training to increase knowledge and develop academic work continuously but also apply innovation into solving problems of their teaching and learning. In terms of mathematics teacher standards of the Institute for the Promotion of Teaching Science and Technology (IPST), it was found that from Standard 10 of mathematics teacher knowledge, teachers were supposed to possess knowledge and understanding and realize the importance in creating good relationship with colleagues and community. In terms of expressing behaviors, they were supposed to coordinate relationship with colleagues, community, and community organizations so as to manage learning chances and integrate knowledge which was meaningful to students.

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7. In terms of the skills in developing students, it was found that the variance was 1.66. They contained six indicators. When ordering based on the factor loading, the first three indicators were "possess patience in waiting for student answers without telling answers or summarizing before allowing students to think and solve problems by themselves," "Enhance students to realize mathematics process skills in order for them to study happily," and "Employ situations or give examples of their own and others who applied mathematics concepts into their daily lives." This finding was in accordance with that of the Institute for the Promotion of Teaching Science and Technology (IPST: 2009) in that teaching students to know how to think took longer time than teaching them how to memorize. Teachers had to be patient in questioning to

stimulate students to think and be patient while waiting for their answers. However, the results were more worth. In management mathematics learning in the lower secondary schools, teachers were supposed to stimulate thoughts, imagination, and challenge students' abilities in a form of new activities aiming to develop thoughts and skills through operational process rather than to figure out right answers (Umporn Makhanong: 2010). When assigning students mathematics work, teachers were supposed to give students a chance to apply concepts and skills in mathematics processes that were modern and relevant to daily lives while solving integrative problems (the Institute for the Promotion of Teaching Science and Technology: 2012).

8. In terms of the psychological characteristics in developing students, virtue, morality, and professional ethics, it was found that their variance was at 1.58. There were 13 indicators. When ordering based on the factor loading, the first three indicators were "be fair and possess democratization," "love, have faith, and possess pride toward their profession and mathematics teacher status," and "be responsible for their assigned duties or directly relevant ones." This finding was in accordance with the research of Laddawan Seupjit (2013), the Office of the Welfare Promotion Commission for Teachers and Education Personnel (2005), the Institute for the Promotion of Teaching Science and Technology (IPST: 2009), and Siriporn Thipkong (2011). Apart from knowledge and skills in learning management, teachers were supposed to possess characteristics of cultivating virtue and morality to students, possess democratization, accept team opinions and others, and give useful suggestions (Jaturong Intarung: 2009, the Office of the Education Council: 2008).

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5.3.2 The results of constructing and developing a model and an application model of an evaluation model of mathematics teacher competency in the lower secondary schools

5.3.2.1 The evaluation model of mathematics teacher competency in the lower secondary schools was a structure expressing relationship among five elements which were (1)evaluation goals, (2) evaluation scopes, (3) evaluation operation, (4) evaluation result judgment, and (5) result reporting and evaluation result application. This matched the concepts in developing an evaluation system of Nevo (1983) in that the model could answer in the aspects of evaluation definition, roles and duties of an

evaluation model, evaluation goals, evaluated variables, evaluation criteria, those who applied the evaluation results, result evaluation steps, evaluation methods, evaluating assessors, and evaluation standards in judging the evaluation. It was also in accordance with an element determination of an evaluation model of mathematics teacher competency in this research. The researcher would discuss the findings in each element as follows.

1. The evaluation goals were to evaluate mathematics teachers in the lower secondary schools graduated from a major they were teaching in which were mathematics or statistics or a minor in mathematics, and those whose majors were not mathematics in order to inspect whether those teachers possessed sufficient competency or not in teaching specific subjects, especially mathematics. The goals determined were based on the concepts of developing an evaluation model of Sirichai Kanchanawasee (2009) and Somwang Piriyanuwat (2541) cited in Rattana Buason (2007) in that the evaluation had to have clear goals in applying the evaluation results to develop the development at a level of individual or organizational. In addition, the evaluation model could be used to evaluate students in mathematics study who had to possess complete competency in order to get ready or determine the guidelines in developing competency so as to prepare for mathematics professional teachers.

2. The evaluation scopes emphasized on evaluating mathematics teacher competency in eight elements and 63 indicators. Determining a clear evaluation frame was a key concept in developing an evaluation model as stated by the Office of the Civil Service Commission (2002) cited in Ratchatawan Sritrakul (2006) in that prior to the evaluation, there were supposed to be the determination of a conceptual frame. Which frame could be used to evaluate competency? What type of competency could be measured inclusively and completely while evaluating. As for the evaluation of the mathematics teacher competency in the lower secondary schools, the competency scopes were determined in three key elements which were (1) competency on mathematics content knowledge, (2) competency on mathematics learning management skills, and (3) competency on psychological factors in developing students, virtue, morality, and professional ethics. It was found that these were in accordance with the content used as a frame in evaluating the operational performance of Chanathip Tuipae

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(2008), Gibson and Hunt (1965), Borich (1977), the Office of the Welfare Promotion Commission for Teachers and Education Personnel (2005). Likewise, Thatsanarong Jarumaetheechon (2013) synthesized primary teacher competency under the Office of the Basic Education Commission, it was found that the work content was necessarily determined to apply in an evaluation that was in accordance with behaviors expressing knowledge, ability, skills, feelings, thoughts, and individual characteristics of teachers. It was also in accordance with that of Phaiboon Meesin (2006) who developed an evaluation model of professional standards stating that the key steps of evaluating were the determination of professional standards which established what to evaluate, what competency scopes were to be determined, what guidelines were to be evaluated, and how to judge the evaluation results.

3. The evaluation operation of mathematics teacher competency in the lower secondary schools.

The researcher determined the details including assessors, evaluating tools, evaluating methods, and evaluation time periods as these four parts were important in that they enabled the evaluation results to be reliable. Similarly, the Joint Committee on Standards for Education (1988) proposed that the reliability of assessors and those applying an evaluation model had to be sufficient for the evaluation so that the evaluation results were then reliable and acceptable. According to the synthesis of the study results regarding the evaluation of teacher competency, it was found that data application from any source that could reflect reality the most enabled accurate operational result evaluation. In order for the evaluation to be inclusive, accurate, and reliable, the evaluation model determined the assessors of mathematics teacher competency in two groups which were administrators or their representatives, teacher peers, and students who would evaluate mathematics teachers. The second group consisted of the mathematics teachers who would evaluate themselves so that they could gain data for developing themselves and acknowledge data regarding their competency. They could use the evaluation results to determine a frame of developing teacher competency efficiently and effectively for the sake of developing students, those relevant, and educational institutions. In terms of the evaluation methods, the easiest and most popular ones were self-evaluation and the evaluation done by those ultimately

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relevant to the teachers as they dealt with discussion and shared consultation. In terms of the tools used to evaluate mathematics teacher competency which were a 4-chioce objective testwhich was a technique used to evaluate knowledge competency in order to measure individual abilities inclusively under the condition of testing in evaluating knowledge competency in mathematics content and relevant knowledge. Additionally, a check-list form in evaluating skills in learning management, problem-solving, and developing students was used to examine a list for observing teacher behaviors together with the interview and supplementary documents and evidence. The opinion questionnaire in a rating scale, which was a popular evaluation technique on a basis of an evaluation form on a Likert scale, was also employed to evaluate psychological characteristics in developing students, virtue, morality, and professional ethics. Apart from determining the evaluating tools, the researcher identified methods and steps in applying these tools, including data processing methods, as a part of an evaluation model so as to be a guideline for those applying the model into their evaluation of mathematics teacher competency accurately as proposed by the Joint Committee on Standards for Education (1988). The committee stated that the description of evaluation goals and methods were supposed to be examined, monitored, and explained in sufficient details so that the evaluation could be performed. The data sources were supposed to be informed sufficiently so that the evaluation of data would be accurate assuring that the data interpretation would lead to reliability and confidence in evaluating competency.

4. The judgment of the evaluation results contained the following steps.

4.1 Analyze the evaluation results of competency in each indicator. This was conducted by adopting the scores gained from a testing form, a check-list form, and a rating scale form to be calculated in terms of the factor loading of each indicator, the connoisseurs' opinions, and the data sources relevant to the teacher competency evaluation (as detailed in the evaluation manual).

4.2 Analyze the competency evaluation results individually by identifying a sum total of the scores of each competency indicator and the competency evaluation results both overall and particular of each element.

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4.3 Judge the evaluation results by comparing with the evaluation criteria in each competency aspect. This would judge each indicator and consider the overall competency by taking the evaluation results to compare with the determined evaluation criteria. The results would be judged in three groups which were a good competency level, a fair competency level, and a competency level needed to be improved. This was in accordance with those of the Institute for the Promotion of Teaching Science and Technology.

The trying out of an evaluation model of mathematics teacher competency and the judgment of the evaluation results aforementioned were useful toward the competency development as there was a judgment on each competency indicator and also in an overall aspect. This enabled the development guideline determination to be able to determine in details of the competency needed to be developed. Due to the fact that the competency evaluation forms were varied and inclusive in terms of competency dimension needed to be evaluated, the evaluation results were ultimately accurate. In determining the factor loading of competency elements and indicators in every item, the consideration results gained from the connoisseurs while considering an evaluation model of competency were employed in determining the score weight. The researcher then developed the data processing program from an Excel in order to facilitate data analysis, data processing, and the competency evaluation result reporting which needed to be kept confidential. This could be used to develop teacher competency rather than to judge and consider their operational performance.

5. The result reporting and the evaluation result application was determined in the evaluation model in that the assessors could print the evaluation result reports from the data processing program and present the results to those evaluated individually. This could be done by presenting data together with the evaluation and allowing those evaluated to clarify and present additional details. This guideline was in accordance with that of the Joint Committee on Standards for Education (1988) that proposed that an evaluation model was supposed to be in accordance with propriety standards which consisted of a written agreement used as guidelines to allow mutual performance. The evaluation was supposed to be designed and applied with the consideration of being accepted and not violating individual rights. The evaluation was

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supposed to enhance the interaction among one another properly and valuably. The evaluation result application for making decisions in planning and determining guidelines in developing teacher competency was also possible to be used in considering the promotion as "pass" or "not pass." This could be done along with the consideration of elements and indicators that were necessary and proper to develop better teacher competency.

5.1 The assessors in evaluating mathematics teacher competency consisted of those evaluating various sections which were administrators, colleagues, students, and themselves. This was in accordance with the concepts of Amornrat Thipjan (2004) and Somkiet Boonrod (2007) who stated that the assessors in competency or performance, apart from administrators, could be other personnel such as colleagues who would know those evaluated better than others as they experienced their operational steps during their routine work together. Students also perceived the behaviors the teachers evaluated who influenced them directly. These people could evaluate teacher behaviors well. This was in accordance with the research of Manoon Siwarom (1999) who found that the five sources giving data in evaluating teachers were school director assistants, subject department heads, colleagues, and students. Perera (2003) also found that data sources in evaluating teacher competency were teachers, educators, specialized teachers, policy determiners, and stakeholders.

5.2 The indicators and criteria in evaluating mathematics teacher competency in the lower secondary schools. In order for the assessors to use as guidelines in examining and behaving to achieve the determined indicators and criteria together with using as guidelines in modifying and developing themselves and performance, it was found that the connoisseurs mutually agreed that all 63 indicators and evaluation criteria were proper to evaluate mathematics teacher competency. They were feasible in collecting data. The researcher synthesized concepts from documents and relevant research, such as the competency frame of the Teachers' Council (2005), the Office of the Basic Education Commission (2010), Ministry of Education (2011), and the mathematics teacher standards of the Institute for the Promotion of Teaching Science and Technology (IPST: 2002) which were processed well. The indicators and evaluation criteria were also considered and processed properly and feasibly by means

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of a focus group that shared the consideration. The connoisseurs also gave opinions and modified indicators and evaluation criteria enabling all 63 indicators and evaluation criteria to be proper in evaluating mathematics teacher competency. This was in accordance with that of Somkiet Boonrod (2007) who developed an evaluation model of performance in the Office of the Educational Service Area by means of a focus group. It was also in harmony with that of Itsaret Nevarat (2008) who found that the indicators and the evaluation criteria aforementioned were proper and feasible in collecting data at a high level.

5.3 The research methods were a knowledge test while an observation, interview, and document and evidence examination used to evaluate skills in managing learning activities and psychological characteristics of individuals in virtue, morality, and professional ethics were conducted by a test, a check-list, and a rating scale. This was in accordance with those of Borich (1997) and Rattana Chaopricha (1995) in that the operational results were supposed to be employed by means of various methods and tools that could measure the ultimately actual conditions. The tools use to evaluate mathematics teacher competency in the lower secondary schools in this research were a check-list form and a rating scale which were used to evaluate mathematics learning management skills and psychological characteristics in developing students, virtue, morality, and professional ethics, respectively. The reliability value of the tools was quite low as it was a measurement of the psychological characteristics in developing students, virtue, morality, and professional ethics which were hidden internally resulting in measuring difficultly. This was in accordance with Luan Saiyod and Angkhana Saiyod (2000) and Somneuk Patthipthani (2006) who stated that the morality definition was not quite stable resulting in the deviation of measurement. This aspect depended on how they were brought up which was considered individual characteristics. In terms of the tool used to measure competency in learning management skills, a check-list form was used resulting in high reliability and accordance value as the indicators and evaluating toolswere harmonious to the issues needed to evaluate. Therefore, it could be measured and observed (Suwimon Tirakanan: 2007) leading to be acceptable among those who applied the evaluation results. It could be used to construct measuring tools accurately and directly while maintaining to be a representative of that evaluation (Phitsanu Fongsri: 2006).

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5.4 The evaluation time period for evaluating mathematics teacher competency in the lower secondary schools was set to perform once a semester so that the evaluation could aim at monitoring teacher performance behaviors. This could reflect the operational results so as to modify the performance in interval in each semester efficiently. This was in accordance with that of Amornrat Thippayajan (2004) who developed an evaluation model of the operation results of the instructors in the Rajabhat institutions. The time period in evaluating the operational results was set once a semester, except for certain indicators such as action research which could be evaluated once a year.

5.5 Giving feedback was also considered an important element of an evaluation model of mathematics teacher competency as it could reflect teacher behaviors and help modify them efficiently (Glass: 1978). According to the evaluation model of mathematics teacher competency developed by the researcher, there were two methods in giving feedback which were as follows.

5.5.1 The individual competency evaluation results were accepted among those who used the evaluation results.

5.5.2 The overall competency evaluation results

5.5.3 The competency evaluation results at a fair level and at a level of improvement needed

5.5.4 The competency needed to be improved and guidelines in developing and enhancing competency was in accordance with that of Millman (1990) in that the feedback gained after the evaluation that was at a high level was supposed to be clarified to the teachers. The guidelines in developing and adjusting the work in order for them to be actually useful and meet the objectives were supposed to be determined.

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5.3.3 The resultsgained from trying out and developing a model and an application manual of an evaluation model of mathematics teacher competency in the lower secondary schools

The steps in applying an evaluation model of mathematics teacher competency and an application model of an evaluation model of mathematics teacher competency were considered a process in developing an evaluation model of competency on a basis of 10 research process steps of the Far West Laboratory for Research and Development (Borg and Gall: 1981). The process of trying out an evaluation model of competency was experimented in a form of (1) a fundamental field examination by applying a model with a small sample group. The data were collected by observation and interview. The experimental results relied on an evaluation model so as to evaluate clarity of a manual, tools, and a processing program used to evaluate the results. (2) The model modification was performed on a basis of the recommendations gained from the fundamental field examination. (3) A key field examination was conducted by applying an evaluation model together with an interview so as to identify data for modifying and correcting. After that, it was employed with a sample group representing the population. (4) A final model modification was conducted on a basis of an actual test in the field.

According to trying out an evaluation model of mathematics teacher competency, the focus was put on inspecting quality regarding structural validity by means of a Known Group technique, together with reliability value and the Rater Agreement Index (RAI). In terms of the structural validity, it was found that the quality level of mathematics teachers was statistically significant. As for reliability inspection, it was found that the evaluation results gained from different assessors were harmonious. These methods could enhance the evaluation to be practical with reality which was in accordance with the concept of Boonchom Srisa-ard (2010). Although the developed model was constructed on a basis of theories and model concepts of others from previous research, it was still a model based on hypothesis which still needed to collect more data from actual situations or from experiments in applying in real situations so as to test whether it was proper, efficient, and useful or not.

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The evaluation results of an evaluation model of mathematics teacher competency in the lower secondary schools included an evaluation in two parts. The former was an evaluation in terms of theoretical propriety examined on model quality by nine connoisseurs based on a standardized evaluation model developed by the Joint Committee on Standards for Education Evaluation. It was found that an evaluation model in an overall aspect was at a high or highest levels of quality in every standard. This presented that an evaluation model responded to the needs in applying the evaluation results to real practices. The evaluation model was feasible and completely inclusive both legally and morally. It also gave information which covered completely as needed. The latter was a quality evaluation gained from trying out with mathematics teachers, administrators, teacher peers, and students. It was found that the model quality in terms of utility, feasibility, propriety, and accuracy standards was at the highest level in every standard showing that the evaluation model was practical. The result application could yield useful information among those relevant. The process in developing a model relied much on conceptual accuracy on a basis of context study, the analysis and synthesis of problems and needs via the connoisseurs, actual trying out, qualitative and quantitative evaluation, and model modification based on gained data in order to decrease most limitations. Those who employed the model the model was proper as stated in the standard of inspecting a model quality at the highest level which was in accordance with that of Somkiet Boonrod (2007) who found that the evaluation model developed could be used in actual situations. The evaluation data of the operational performance were accurate and inclusive with reality. Chanathip Tuipae (2008) found that the satisfaction evaluation both overall and separate in terms of a particular element of a performance evaluation system was at a high level. When considering a quality evaluation as stated in the standard, it was found that every standard possessed quality at a good level. It was also in accordance with that of Amornrat Thippayajan (2004) who developed an evaluation model of instructor performance in Rajabhat institutions in that all of the seven elements of an evaluation model regarding operational performance developed were feasible to be applied into actual situations, accurate with reality, and harmonious with evaluating policies, and ultimately useful.

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5.3.4The study results of the guidelines in developing and enhancing the mathematics teacher competency

It was found that the guidelines in developing and enhancing mathematics teacher competency consisted of the knowledge in mathematics learning content and fundamental knowledge regarding curriculum application, the skills in managing mathematics teaching and learning, virtue, morality, and professional ethics. The median and the difference between quartiles were considered. The guidelines in developing and enhancing mathematics teacher competency consisted of 23 minor guidelines within key guidelines which were guest-speaker-centered training, attendant-centered training, mentoring, supervision and monitoring, self-study via various media, group exchange, orientation prior to teaching, discussion and summary together, regular meetings, and study leave both in and out of time. These guidelines were in accordance with those of the Office of the Education Council(2008) that studied teacher competency and guidelines in developing teachers in changing societies. It was found that Thailand and foreign countries determined a conceptual framework which was harmonious in 15 aspects. These might contain slightly different details depending on social contexts of guidelines in developing teachers to possess ultimate competency while modifying their teaching and learning efficiently. These guidelines could be used as policy approach so as to be guidelines in developing teacher competency toward the Office of the Basic Education Commission and those relevant to all three competency aspects in each element and indicator. According to 25 research articles regarding mathematics teacher competency, the guidelines in developing and enhancing mathematics teacher competency found were harmonious. The key management in terms of developing and enhancing mathematics teacher competency were as follows.In terms of teaching and learning activity management, there were supposed to be a focus on mathematics processes and skills, knowledge in mathematics content, knowledge in measuring and evaluating regarding mathematics measuring tool construction. In terms of cooperation in supervising and monitoring mathematics teachers, a seminar among teacher groups that mathematics teachers operated by themselves was supposed to be conducted. In terms of preparing plans, a focus on procedures, media preparation, and a variety of presenting measuring and evaluating methods was supposed to be considered. These would enable teachers to possess knowledge and understanding the guidelines in

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managing learning activities that focused on a particular problem issue continuously. This was a key method in developing mathematics teachers. Moreover, guest speakers from the local might be supplemented to enhance mathematics teachers so that they would possess trust and readiness to develop themselves harmoniously with their school contexts.

Moreover, the guidelines in developing and enhancing mathematics teacher competency found were in accordance with those in developing teachers based on the guidelines of the United States, Australia, and Canada (the Office of the Education Council: 2008). Phasina Tangjuang (2011) and Ronnakorn Nonyaso (2013) stated that there was supposed to be a plan in developing teacher competency systematically with a program in constantly enhancing new knowledge among teachers both short and long terms. This could be cooperated with offices or a network organization, such as universities or higher education institutions both state and private in the local, or local connoisseurs. Proper methods in developing teacher competency, such as self-study via distant media, e-Book, e-Learning, radio, TV, training, seminars, field trip, and internship, were used. And, the offices responsible had to be a standardized network in overseeing and helping teachers attending in competency development continuously and regularly.

5.4 Recommendations

Recommendation on model application

1. School administrators or educational institutions containing mathematics students were supposed to use an evaluation model of mathematics teacher competency to evaluate competency that was in accordance with their needs in competency elements in order to search for necessary competency needed to be improved urgently. The evaluation results were also developed together in order to determine a guideline in developing themselves among mathematics teachers.

2. The result evaluating program was developed from an Excel which was fundamental and convenient to use. Those evaluated and assessors could process data by themselves. However, there was supposed to have the evaluation on all competency elements. In case of not having all elements, the evaluation results might not be

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accurate. Moreover, the results of evaluating teacher competency were supposed to be confidential as an evaluation for development. Those relevant were supposed to be informed so that they possessed understanding.

3. There was supposed to have a communication between assessors and those assessed in order to gain understanding in case of getting different evaluation results. The evaluation results were used to determine development guidelines together so as to create acceptance in the evaluation results and cooperation in developing mathematics teacher competency in the lower secondary schools later.

4. Educational institutions were supposed to consider importance levels of mathematics teacher competency in the lower secondary schools from top to bottom. Urgency in developing in case of having competency at a high level needed to be developed affected the ultimate efficiency toward learning management. This was supposed to be operated before with planning in a long run.

5. The evaluation of mathematics teacher competency in the lower secondary schools regarding a knowledge element of mathematics content could be done by computer systems in order to help while doing the objective tests aiming at covering knowledge body. With the help from computers, teachers could be evaluated at their convenience in time. Moreover, the evaluation results could returned to them instantly and individually.

6. The evaluation of mathematics teacher competency in the lower secondary schools would be operationally successful or not depending on the fact that the educational institutions gave knowledge to those responsible for evaluation and those relevant regarding knowledge, evaluation skills, data collection methods and techniques, interpretation analysis, summary, and evaluation result reporting or not.

7. Higher offices, such as the Office of Educational Service Area, the Office of the Basic Education Commission, and those relevant, were supposed to have policies so that the educational offices would operate the evaluation on mathematics teacher competency systematically and constantly under control and monitoring on innovation and an evaluation of educational administration.

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8. Educational institutions were supposed to consider who could participate in evaluating teacher competency in each competency aspect so that the information gained would be most practical.

9. Mathematics teachers evaluated were supposed to possess knowledge and understanding in an evaluation model with adopting the feedback of the evaluation results to modify and develop continuously. They were supposed to analyze to figure out causes and guidelines in modifying and developing so as to achieve as set in the criteria.

10. This evaluation model of mathematics teacher competency could be used with mathematics teachers at other levels. However, the guidelines of evaluating knowledge and skills of teachers might be modified based on the objectives they needed to emphasize in managing teaching and learning in each level to be in accordance with propriety.

11. The offices responsible for policies in managing basic education and the Office of Educational Service Area were supposed to use the research findings regarding an evaluation of mathematics teacher competency and guidelines in developing and enhancing this competency so as to determine in their planning, projects, or activities for the sake of teacher development in their educational institutions efficiently.

5.5 Suggestions for Further Research

The researcher proposed an opinion for further research so as to develop a variety of research so that it could be used as guidelines in developing teacher competency more completely as follows.

1. The developed evaluation model of mathematics teacher competency in the lower secondary schools was based only at the lower secondary level. Teacher competency in different contexts, such as class interval and subject content groups, could be different. Therefore, other research done in different contexts was supposed to be conducted.

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2. In terms of research conducted to develop elements and indicators of mathematics teacher competency, the researcher was supposed to develop additional indicators specifically, such as teaching method elements or innovation and media elements, and analyze confirmatory factors in order to inspect structural validity as well.

3. The evaluation model of mathematics teacher competency in the lower secondary schools focused only on schools under the Office of the Basic Education Commission. Therefore, the researcher was supposed to develop an evaluation model of mathematics teacher competency in different affiliation so as to be able to be compared for further educational development.

4. The tools used in evaluating mathematics teacher competency in the lower secondary schools for this research in terms of mathematics learning management skills were a check-list form. In terms of psychological characteristics in developing students, virtue, morality, and professional ethics, a rating scale was used. It was found that the reliability value of these two was different. Therefore, the research was supposed to be conducted in order to develop proper tools used to evaluate teacher competency for further evaluation.

5. Research was supposed to be conducted in order to identify guidelines in developing and enhancing teacher competency in various subject content in different issues as follows.

5.1 Other research methodology was supposed to be used, such as policy research and participatory action research.

5.2 In terms of data collection, apart from inquiring the connoisseurs by means of a questionnaire, the interview which was a key method in collecting data of research could be employed in order to gain sufficient data for the sake of research development completely.

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