### CHAPTER 3 METHODOLOGY

This research, entitled Construction of a Model for Developing Instructional Competency Promoting Prathom Suksa 6 Students' Mathematical Process Skills Through Knowledge Management and Action Research, is a kind of research that employs both qualitative and quantitative research methodologies. The researcher implements the research methodologies as the following manners.

Step 1 is the step of developing the conceptual framework to develop the model for the development of the instructional competency promoting the mathematical process skills.

Step 2 is the step of designing the instructional competency development that promotes the students' mathematical process skills.

Step 3 is the time of implementation the model for developing the instructional competency promoting the mathematical process skills.

Step 4 is the evaluation and improvement of the development of the model to develop the instructional competency promoting the mathematical process skills.

The details of the implementation of each step are given as the followings.

Step 1 (the step of developing the conceptual framework to develop the instructional competency promoting mathematical process skills) is where the researcher studies the problematic conditions in the teaching of mathematics in Prathom Suksa 6 level as well as the principles and concepts in developing the teachers by using various models to use in identification of the conceptual framework for the research. For this research, the researcher is interested in using the principles and concepts of action research and knowledge management as reviewed in Chapter 2 (Parts 3 and 4)

to apply to use in developing the instructional competency of mathematics among the Prathom Suksa 6 mathematics teachers. Focusing on the development of the instructional competency, the researcher prepares the teachers to be able to arrange the teaching and learning methods that promote the mathematical process skills of the students along with the teaching the contents. This interlinked process is presented as the conceptual framework of the research and shown in Figure 7.



Figure 7 The Research Conceptual Framework

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Step 2 (the step to design the instructional competency development that promotes mathematical process skills) is where the researcher prepares a draft for the model for developing instructional competency promoting mathematical process skills by using the knowledge management and action research based on the Conceptual Framework in Step 1. Then this draft model is brought for consultation with the thesis adviser and five experts who have knowledge and abilities in mathematics, in research, and in personal development (Appendix A, page 166) in order to ask their opinion about the appropriateness and feasibility of the model for developing instructional competency. Afterwards the opinions and suggestions from the experts are used to revise the model to use in actual research. The model is shown in Figure 8.

Step 3 (implement the model for developing instructional competency promoting mathematical process skills) is the step where the researcher implements the following processes.

1) Selection of the group of teachers as targets to implement the model for developing instructional competency promoting mathematical process skills: eight teachers from in the schools under the Office of Chiang Mai Education Service Area 2. These teachers are selected according to their qualifications identified by the researcher, which are their position as teachers of mathematics at Prathom Suksa 6 level and their voluntary participation into this research. Moreover, they must be open-minded, tend to build good relationship with others, acquisition of basic knowledge of mathematics, and working in the readily accessible schools (not in isolated rural areas with difficult communication). The school administrators equally show willingness to cooperate in the research. The target group teachers are needed because the research implementation requires meetings and exchanges of the learning results from time to time and also involves data collection, insights or detail information before, during and after the model development. However the number of target group teachers is limited in order to facilitate convenient implementation. Thus only one teacher is selected as the member of the target



Figure 8 The Model for Developing Instructional Competency Promoting Mathematical Process Skills

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group teachers from each school (all eight schools). The total number of teachers selected for this research is thus eight mathematics teachers.

2) Implementation for the created model to develop the instructional competency after acquiring research permission for the thesis from the Director of the Office of Chiang Mai Education Service Area 2 and the administrators in the schools from where the teachers are selected. Then the researcher implements the designed model to develop the instructional competency as produced in Step 2 between 28 April 2007 and 31 March 2008 as the followings.

Sub-step 1: This sub-step identifies the targets of success of the model development by using the methods of holding meetings for the target group teachers for two days (28 April 2007 and 5 May 2007) at the meeting room of Ban Rim Tai School. This is the sub-step in which the researcher and the target group teachers identify together criteria and methods of evaluation of the instructional competency promoting mathematical process skills in order to create the clear direction and the field of this development through the study on the known standards and demands of the curriculum, the analysis on self potential of the target group teachers, and the analysis of the students' potential in each school to see the possibility to remark the targets of success in the development of the model.

On 28 April 2007 the researcher arranged a meeting among the target group teachers to create understanding and to stimulate these teachers to be aware of the importance and necessity in developing the mathematics teaching and learning into promotion among the students to have mathematical process skills through the presentation of mathematics learning achievements since year 2003. The results of the evaluation by ONESQA or The office for National Education Standards and Quality Assessment (Public Organization) on the teaching and learning of mathematics are specified on the learning achievements on mathematics, abilities to think, abilities to solve problems, abilities to classify the types of data, abilities in comparison and conceptualization, creative thinking and imagination, abilities to notice problems in the

teaching and learning of mathematics to the Institute for the Promotion of Teaching Science and Technology in mathematics. Some academicians on mathematics teaching have suggested that the teachers have emphasized merely on the contents rather than on the students' mathematical process skills. The teachers also face problems in the teaching of the contents along with the development of students' mathematical process skills. The model of the developmental methods for the teachers is not responsive to the actual problems and demands of the teachers in each area. After proposing the problems and their causes in general, the target group teachers are allowed to analyze the problems in teaching and learning mathematics on their own in order to identify the effective targets of the development. The researcher reveals the knowledge for the target group teachers about the standard of mathematics teachers of the Institute for the Promotion of Teaching Science and Technology, which are the instructional competency of mathematics, the development of mathematical process skills, the concepts in arranging mathematics teaching activities, methods of solving mathematical problems, making teaching guidelines and teaching plan in order to bring knowledge to apply in identifying the standards, indicators, and criteria of development of the instructional competency, promoting the mathematical process skills, including the distribution of documents of drafted standards, indicators, and criteria for the instructional competency that likely promotes the mathematical process skills of the students. The target group teachers are also urged to study deeper and to think about teaching improvements together in future meetings.

On 5 May 2007 the target group teachers reviewed together the known standards, indicators, and the instructional competency criteria including the criteria to evaluate the mathematical process skills among the students by considering on the possibility of the implementation to achieve the success to create supports for the implementation. This review considered the limited basic and limited environment on the implementation of each of the teachers and students who are belonging to the target groups. The review meeting produced the standards, indicators, and criteria to consider on each indicator to define the instructional competency that promotes mathematical process skills settled into

5 standards and 17 indicators as well as defined the criteria for the evaluation on the mathematical process skills of the students settled into 5 process skills. After the meeting, the results were printed out and shown to the experts to solicit additional suggestions and to revise appropriately before the use of the model in next implementation using the standard, indicators, and the criteria of instructional competency of the target group teachers shown in the Appendix B (page 167-169) and the criteria to evaluate the mathematical process skills of the Prathom Suksa 6 students shown in Appendix C (page 180-182).

The targets of "success" in the development of the instructional competency promoting the mathematical process skills of the Prathom Suksa 6 students are identified as the results where all scores in the tests for quality level during the implementation are higher than the results of evaluation before the model development and implementation (at least one level).

The summarize the implementation in this step, the researcher implements the creation of the awareness for the target group teachers to see the importance and necessity to develop the mathematical process skills of the students, to analyze problems together, to exchange learning and share the necessary knowledge required to use in identifying the targets of success in the development, and join together with the target group teachers to identify the instructional competency promoting the mathematical process skills of the students in form of standards, indicators, and criteria. This creation of awareness includes joint discussion in identifying the targets of success in the model development according to the concept of knowledge management stating that "the knowledge management must start at the work or the target of the work" (Vicharn Panich, 2005 : 4). The whole steps of the process are shown in Figure 9.



Figure 9 Summary of Steps in Identifying Targets of Success in Learning and Teaching Model Development

Sub-step 2: This sub-step reviews the instructional competency to promote the mathematical process skills before the model for learning and teaching is developed. This is a review based on the standards, indicators, and criteria identified in Step 1 to check how high each of the target group teachers has shown the levels of instructional competency that promotes the mathematical process skills in each standard and in each indicator. Is it necessary to develop more standards or indicators? In addition the results of this reviewing can be used as the baseline (Based Line) in comparing the progress of the development of instructional competency promoting mathematical process skills of the target group teachers who are exposed to the development of the model created by the researcher.

The researcher arranged the meeting with the target group teachers on 12 May 2007 to exchange the learning about the measurement and evaluation results in the content-areas of mathematics and to give additional knowledge about identification of methods and tools used in the measurement and evaluation of the knowledge, process skills, and other qualifications including creating and seeking for the quality of the tools used in the evaluation on the mathematical process skills. After that the researcher and the target group teachers discussed the identification of methods and tools used in the instructional competency that promotes the mathematical process skills according to the standards and indicators identified in Step 1, which are given as the followings.

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1) Standards 1 to 4 identify the methods to crosscheck (or called Methodological Triangulation) through methods like the evaluation of the instructional competency from the classroom visits and the tape recording of the teaching, interviews with the target group teachers, and study on related literature, i.e., the trace of checking the exercise or the students' tasks, the analysis of the teaching and learning arrangement plan, the record of reflection of data after the teaching, and the record of the model implementation process in the classroom of the target group teachers.

The created tools for collecting the data from data sources are the evaluation forms on the teaching promoting mathematical process skills, the record forms for interviews with the target group teachers, the record form of the trace on checking the students' exercises or tasks, the evaluation forms of the teaching plan that promotes the mathematical process skills, the record forms of the data reflection after the teaching, and the report forms of the implementation in the classrooms of the target group teachers. After the researcher designed and created these tools, they were brought to the target group teachers for consideration, discussion, and open forum for additional suggestions. After that the tools were presented to the experts to solicit their suggestions in purpose of making revisions before the tools were used to measure the samples' levels of instructional competency in June 2007. After that the researcher brought the results to analyze for each standard (the results of analysis are presented in Chapter 4).

2) Standard 5 considers from the outcomes of the measurement of the levels of the mathematical process skills of the students after the teaching and learning arrangement done by the target group teachers who gather the data from the observation and the evaluation of the students' tasks. The students' capabilities are measured by the researcher through the created test forms in essays form that is set to cover all of the measurement indicators. The checking of the tools' qualities is done by the experts and then the target group teachers are asked to apply such test form into their classrooms to measure the students' mathematical process skills in June 2007. The answer sheets are collected and sent back to the researcher by 2 July 2007. After that the researcher checks all of the students' answer sheets by using the evaluation criteria on the measurement for

the mathematical process skills of the students that have been created by the researcher and the target group teachers in Step 1. The results of this analysis are presented in Chapter 4.

To sum up, for the important activities in this sub-step are composed of exchanging the learning after the evaluation of the mathematical process skills, providing supplementary knowledge for the target group teachers, applying the knowledge to build the tools to be used for measurement, confirming the qualities of the tools, applying the tools in measuring the target group teachers' instructional competency and their students' mathematical process skills, analyzing and summarizing the results of the model development. As shown in Figure 10, in building up the tools for the evaluation the researcher uses the concepts known in Knowledge Management such as Access to Knowledge, Exchange of Learning, Self-Creation of Knowledge, and Application of Knowledge into Practice to achieve a successful implementation.



Figure 10 Summary of Order of Activities in Checking the Instructional Competency that Promotes Mathematical Process Skills before the Model Development

Sub-step 3: This is a step to create a plan for developing the instructional competency that promotes the mathematical process skills where the researcher brings the data derived from the checking of the instructional competency from the Step 2 to analyze which standards and indicators that the target group teachers should develop further.

The researcher uses the concepts of Knowledge Management such as (1) identification of the target of "success", (2) identification of the necessary knowledge for the development of the model, (3) construction of knowledge necessary for the model development, (4) seek the learning and exchange the learning, (5) improvement, adjustment and creation of knowledge to develop the model, (6) bring the knowledge to application, and (7) exchange the knowledge with relevant others. The researcher also records the knowledge or the experience gained from the performance or implementation and uses the concept of Action Research such as planning, action, observing, and reflecting to design the development of the instructional competency that promotes the mathematical process skills of Prathom Suksa 6 students by identifying the steps of implementation for the target group teachers into the following seven steps.

1) Identify the targets of success in developing of the teaching and learning arrangement.

2) Make the teaching guidelines.

3) Analyze and self-evaluate.

4) Exchange the learning results before model development.

5) Bring the knowledge to arrange the teaching and learning.

6) Exchange the learning after development.

7) Summarize and prepare the teaching and learning arrangement for next teaching sessions.

These seven steps will move in a circle of continuous implementation as shown in Figure 8, which shows the cycle of development in parts of the target group teachers. The researcher identifies the activities for development of the instructional competency that promotes mathematical process skills of the target group into three main activities as the followings.

Activity 1: The preparatory meeting and production of the implementation plan is the meeting of target group teachers to identify the targets of success in the teaching and learning arrangement in each lesson in order to analyze and evaluate the teaching competency that promotes mathematical process skills of the target group teachers, to exchange the learning and summarize the knowledge of the target group teachers, and to arrange the teaching guidelines or to create the teaching media and tools, which will be used as parts of teaching and learning.

Activity 2: The implementation in part of the target group teachers is applying the knowledge gained from the meeting in Activity 1 to use in the teaching and learning arrangement in each of the teachers' school. The application of the knowledge into implementation uses the action research process which is composed of planning for teaching and learning arrangement, arranging the teaching and learning according to the teaching plan, and evaluating and reflecting gathered information after the teaching by arranging each of the teaching and learning which have linkage in the cycles of implementation. The researcher is responsible as the evaluator who advises the implementation by the target group teachers through emphasis on the teaching that promote the students' mathematical process skills.

Activity 3: The meeting to exchange the learning results. The meeting gathers and shares the knowledge and experience derived from the data reflection by each of the teaching and learning arrangement between the target group teachers and researcher, including making implementation plan for future teaching sessions.

These main activities will move on continuously until the end of the semester. The researcher identifies the time period of the implementation starting from the Activity 1 on the weekend of 1-2 September 2007. The calendar schedule for implementation in next time will be arranged each time whenever the available time of the target group teachers and the researcher can be settled. To sum up, the important activities in this step are composed of studying the data derived from the measurement of the teaching competency of the target group teachers that promotes mathematical process skill (before the model development). By bringing such data to design the method to develop the instructional competency through the concept of Knowledge Management and Action Research to be integrated into the regular teaching and learning arrangement of mathematics learning, the calendar schedule for the development can be shown in Figure 11.



Figure 11 Summary of Activities on Planning for the Development of Instructional Competency that Promotes Mathematical Process Skills

Sub-step 4: This is the sub-step where the researcher develops the instructional competency of the target group teachers according to the plan. The researcher implements the development for the instructional competency according to the following plan.

Activity 1: The researcher begins the implementation during the weekend (Saturday and Sunday) of 1-2 September 2007 by inviting the target group teachers in a meeting of making plan for teaching and learning mathematics together and allowing the target group teachers to study together on the learning contents (Lesson Unit 8 on the decimals, Lesson Unit 9 on adding, subtracting and multiplying the decimals, Lesson Unit 10 on dividing the decimals). Then the participants discuss together the identification of the target of success, especially on the levels of mathematical process skills. After this series of discussion with the target group teachers, it can be concluded that in one learning unit the teachers can implant into the students all five mathematical process skills, which are solving problems, reasoning, communicating and presenting the mathematical concepts, making linkages among concepts, and producing creative thinking. In each teaching plan the teachers may identify the development of certain mathematical process skill but not all five mathematical process skills in a single teaching plan. This plan, however, depends on the suitability and consistency of the learning contents and the emphases of the teachers' plan of skill development. After that the target group teachers design and prepare the guidelines for the teaching and learning arrangement in Lesson Unit 8 (the decimals), Lesson Unit 9 (adding, subtracting and multiplying the decimals), and Lesson Unit 10 (dividing the decimals). The learning objectives of five mathematical process skills are thus identified.

After designing the guideline for the learning arrangement, the researcher requests the target group teachers to self-evaluate their activities through analysis of the teaching and learning arrangement in the three lesson units on the decimals. The target group teachers must analyze in which knowledge they have or have not built sufficient knowledge. This analysis can be done through a comparison of the teachers' skill

measurement to the standard criteria, indicators and identified criteria as identified in Step 1. The results of this analysis and self-evaluation of all the target group teachers for each standard are found to be in the level of "need improvement" and thus it is confirmed that the past teaching and learning arrangement lacked emphasis on the building of students' mathematical process skills. Although the curriculum has identified the mathematical process skills as the contents number 6 but most practitioners appear to emphasize solely on the learning contents. After the analyses show that the teaching and learning arrangement on the decimals must be done along with the building of the mathematical process skills, the target group teachers self-analyze themselves that they have sufficient knowledge and experience on teaching the decimals because each of them have taught mathematics for more than 10 years. However the additional knowledge that they need is the building of the mathematical process skills because this is the new topic identified in the curriculum.

The researcher adds the knowledge on the mathematical process skills along by giving the summary documents of knowledge on the development of the mathematical process skills, mathematics teaching techniques, methods of questioning (asking questions), creation of teaching and learning media, evaluation methods, knowledge management and action research for the target group teachers. The researcher also manages the open discussion for the target group teachers to exchange the learning using the data, i.e., arranged group of knowledge of the teachers in each standard according to the evaluated data evaluated in Step 1. The researcher also provides the target group teachers some suggestions about the additional learning sources about the mathematical process skills such as the manuals to arrange the content-areas of mathematic in the class level 1-2, the Basic Education Curriculum, the manuals for mathematical evaluation from the Institute for the Promotion of Teaching Science and Technology, and mathematics reasoning in Prathom Suksa level based on the Basic Education Curriculum B.E 2544 (2001) of the major of Basic Mathematics (from the Institute for the Promotion of Teaching Science and Technology). There are also contents and topics concerning the mathematics activity arrangement in the Reformation Era under the Office of Mathematics and Computer, the Institute for the Promotion of Teaching Science and Technology, and other sources of information from websites, especially the websites of the Institute for the Promotion of Teaching Science and Technology (<u>www.ipst.or.th</u>). After the analysis based on teachers' self-evaluating and sharing the learning, the target group teachers join together in designing the guidelines in the teaching of the decimal that all of them can utilize flexibly as the guidelines for proper teaching and learning plan for their own environment.

Activity 2: This is the personal activity where the target group teachers apply the knowledge and the guidelines to arrange the teaching and learning that they have learned from the meetings in Activity 1 into the teaching and learning arrangement for the second semester of the year 2007 (starting from November 2007 onwards). In the teaching and learning arrangement, the target group teachers use the action research process to implement the following activities.

1) Application of the guideline for teaching and learning arrangement, preparation of details of teaching and learning arrangement plan for next sessions of teaching in each day, and preparation of the media, teaching and learning equipments.

2) Arrangement of the teaching and learning according to the created plan.

3) Check and review of the students' levels of knowledge before, during and after the teaching and learning session for each daily plan.

4) Summarization of reflection of data gathered after each of the teaching session.

For the summary of the results of the teaching and learning arrangement (instruction) in each lesson, the researcher and target group teachers discuss together and summarize that the target group teachers should prepare the report folder (portfolio) of their plan implementation in the classroom. Each folder is composed of the parts of the report for the classroom implementation with the following important topics.

1) The desired quality that the teachers expect from the students to acquire whenever they finish the lessons (e.g., knowledge, mathematical process skills and desirable characters or attributes).

2) The methods used in the development of the students' quality (focusing on the activities and the plan to arrange the learning in all plans).

3) Evaluation methods.

4) Summary of implementation results according to the plan.

5) Discussion for insightful suggestions for development of future learning units.

6) Appendix, which is the evidential documents used for arranging the activities in the teaching and learning plan in certain unit such as the test form (pre-lesson), posttest form (after-lesson), the results of the tests before the learning, and the results of the test after the learning of each student.

In these activities the researcher will be the one who provides suggestions in the teaching and learning arrangement that promotes mathematical process skills of the target group teachers, regularly visits the classroom after informing the schools in advance (one school for each visit), offers suggestions as the whole picture in general, and gives additional suggestions about the teaching and learning arrangement which focus on the mathematical process skills when the teachers share the results of their classroom implementation to the meeting and exchange the learning (after the teaching on three lessons on decimals on Saturday of 21 December 2007).

Activity 3: The researcher invites the target group teachers to bring the results from the teaching and learning arrangement for the three lessons of the decimals to exchange the learning with one another by identifying the issues of the exchange of learning as the followings.

1) How much is the benefit gained from the sharing of learning during the month of September 2007 that can be brought to use in the teaching and learning arrangement to promote mathematical process skills?

2) What are additional suggestions about sharing the learning?

3) How useful is the guideline for the teaching and learning arrangement to be used to develop the teaching and learning that promotes the mathematical process skills? Are there clear benefits and what else needs to be improved? How to achieve those improvements? 4) What are the perceptible results from the teaching and learning arrangement of each of the target group teachers? Are there obstacles to overcome and needs to be improved? How to do that?

5) In the teaching and learning arrangement of the next Lesson Unit (Lesson Unit 11 on Squares and Lesson Unit 12 on Circle), what are the likely knowledge that the target group teachers need to properly arrange the learning that helps the students to achieve the learning standards and thus build the mathematical process skills? What factors that may allow the teachers to analyze and self-evaluate the results through emphases on the comparison, standard criteria fulfillment, and indicators of the instructional competency that promotes mathematical process skills created in Step 1? How can each of the teachers position each comparatively within the other members for achievement in each standard? Who has higher or lower levels of competency regarding the activities starting in Step 3 of the implementation cycle of the target group teachers?

The researcher is responsible for stimulating the sharing and exchange of learning as well as giving additional knowledge about using teaching media that promotes mathematical process skills, i.e., mathematical games, supplementary activities of mathematical skills, the Geometer's Sketchpad Program (GSP), and mathematical websites as the followings.

- <u>www.ipst.ac.th</u> (Institute for promotion for Teaching Science and Technology).

- http//202.29.77.139/primath/home/index.asp (major in basic mathematics, the

Institute for Promotion for Teaching Science and Technology).

- http//thaigsp.ipst.ac.th (The project that promotes the use of Information Technology in order to teach the Geometer's Sketchpad Program or GSP).

- http//www.dynamicgeometry.com (additional learning sources about the GSP).

- http://www.mathsnet.net/geometry/solid/index.html (the teaching media on digital mathematics).

The researcher gives additional knowledge and cooperates with the development of the activity implementation for the target group teachers by inviting the trainers who have specialties in the program of Geometer's Sketchpad, San Sai Luang School, San Sai District, Chiang Mai Province such as Miss Paradee Thusneetum who is the trainer on the principles of using the program and the training to use the program (for one day session).

The summary of the step in developing the instructional competency that promotes the mathematical process skills is shown in Figure 12.



Figure 12 Summary of Activity to Develop the Instructional Competency that Promotes Mathematical Process Skills

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Sub-step 5: The researcher observes, checks and reflects the development of the learning and teaching model. This is the step of checking and reviewing the results of the instructional competency developing promoting the mathematical process skills, which are designed and planned in Step 3, to measure the levels of changes or developments among the target group teachers. This sub-step also checks or reviews the methods used in the model development to see whether they are appropriate or not. The checks cover any of the changes, improvements, or corrections on the techniques of development. The checking or reviewing during the development is done to bring the derived data to improve the development of the process, the methods to increase its appropriateness to the situation and the readiness of the implementation among the target group teachers.

From the checking and reviewing during the model development, it is shown that the target group teachers have perceptibly increased their development on instructional competency. In the earlier period of the development, the rate of development is rather slow because the target group teachers are not yet familiar with one another. Therefore the intensity of the learning exchange is rather limited. Thus the researcher takes responsibilities as the learning facilitator for the target group teachers that they show their opinions openly, propose the knowledge based on each of their own experience, and create a relaxed atmosphere of learning exchange. The learning exchange environment becomes an informal atmosphere. Therefore in the meeting to exchange the learning at later period the venues or places to hold the meeting are moved from the schools to the house of the researcher. There are various forms of problems or obstacles found in this mission within the schools of each of the target group teachers. It is also difficult to make appointment on official work days because the teachers have a lot of teaching duties. Therefore the appointments are easier to manage when settled during holidays or weekends.

The summary of the implementation process in sub-step 5 (Observing, Checking, and Reflecting of Model Development) during the development of instructional competency promoting the mathematical process skills (to bring the data to be used in making revision on the development of the implementation) is shown in Figure 13. The

revision is based on the results gathered from the activities arrangement on the development based on their design and methods in arranging the activities in development.



Figure 13 Summary of Activities on Observing, Checking, and Reflecting on the Development of Instructional Competency Promoting Mathematical Process Skills.

Sub-step 6: This is the sub-step to evaluate the levels of instructional competency that promotes the students' mathematical process skills after the model development and trial. The evaluation is done to check levels of development of the instructional competency among the target group teachers that promotes the mathematical process skill according to the standards and indicators identified in Step 1. The researcher undertakes the evaluation directly between February 2008 and March 2008 by using the following methods.

1) Evaluate the instructional competency from the classroom visit to the target group teachers' classrooms, one teacher for each visit in February 2008. The time

selected for the instructional competency evaluation is decided whenever the target group teachers are arranging and using the teaching and learning arrangement in that time.

2) Evaluate the instructional competency from the tape- recorded teaching sessions of each of the target group teachers' teaching between February 2008 and March 2008, one teacher per one evaluation. The recording is done continuously throughout the time of the teaching and learning arrangement of the teaching plan. The researcher provides the blank cassettes while the target group teachers prepare their own tape recorders.

3) Interview with the target group teachers is done by the researcher in informal interviews with questions concerning the seven teaching issues, i.e., the development of the mathematical process skills, the identification of problems and solutions for the students, the designation of the teaching and learning arrangement, the follow-up evaluation on mathematical reasoning skills, the selection of teaching methods, the use of symbols and formulas, and the use of teaching media and other tools. The researcher selects the questions to be asked in the interviews during the classroom visits and the meetings to summarize and exchange the learning among the target group teachers on 29-30 March 2008. The interviews are done with all the target group teachers and they are asked the standardized questions concerning all issues.

4) Study the related documents which are evaluation of the plan to arrange teaching and learning that promotes the mathematical process skills through the evaluation of the students' exercises or their pieces of tasks, the record forms for the reflection data after the teaching, and the record form of the report of the implementation in the classrooms in all lessons. The researcher asks the target group teachers to send these documents that the researcher can study them during April 2008 to June 2008.

For the evaluation using the Standard 5 regarding the consideration from the evaluation of the mathematical process skills of the students, the researcher creates an evaluation form on the mathematical process skills on Application Unit for the target group teachers to test their students in their classrooms between 1 and 15 March 2008.

The gathered answer sheets are returned to the researcher who will check and score them based on the criteria identified in Step1. The evaluation results are presented in Chapter 4.

Figure 14 summarizes the activities in the evaluation of the instructional competency that promotes mathematical process skills after the model development. The researcher utilizes five methods in the evaluation and the tools created in Step 2 related to the checking step of the levels of instructional competency promoting mathematical process skills before the model development and trial.





Sub-step 7: This is the sub-step to summarize and reflect the results on the development of instructional competency that promotes the mathematical process skills. The researcher brings the results of the evaluation in sub-step 6 to be compared with the criteria created by the target group teachers and the researcher in Step 1 to summarize the results of development, i.e., levels of quality for each standard, comparison of the measurement results before the model development (to summarize the progress of development). After that the researcher prepares the summarized reports of the development results and distributes them to relevant and interested people in general. In this step the researcher reflects on the gathered data of the evaluation results on the mathematical process skills of the students to the target group teachers that the latter know and use such information to develop their own teaching and learning methods. At the same time the researcher gathers opinions (using the questionnaires and discussions of more efficient application of teaching methods) from the target group teachers toward the created model of instructional competency development that promotes the mathematical process skills of Prathom Suksa 6 students.

Step 4 (step of evaluation and improvement and development of the model on teaching competency development that promotes mathematical process skills) is the step where the researcher evaluates the developed model by asking opinions from the target group teachers and evaluates the progress of the instructional competency that promotes mathematical process skills according to the created standards of the development. This evaluation is done side by side with the implementation of Step 3, which is the implementation step for the development model.

To improve the developed model to enhance the instructional competency that promotes the mathematical process skills to be more appropriate to the environment of the implementation of the target group teachers, there are some adjustments to the steps of implementation as the followings.

1) Adjustment of the implementation of the role of the researcher or the knowledge management director according to the developed model, which is previously identified into seven steps (shown in Figure 8, page 79), into four steps (shown in Figure

15, page 116). In Steps 3 to 5 the implementation steps are not clearly separated from each other but appearing more as the continuous implementation in recurring small cycles. Sometimes these steps are integrated into a single step. Steps 5 and 6 are rather similar steps of evaluation for the instructional competency with the different objectives. Step 5 is the checking and reviewing of the implementation of the development to apply the gathered information to improve and develop the development process more efficiently, which can be also called a sub-step of evaluation during the implementation of the model. The evaluation on the Step 6 is undertaken to check the last results if they are acceptable as the set targets; or this may be called the evaluation after the development. This is a series of distinctive steps but the target group teachers may perceive them as overlapping steps. Therefore the researcher integrates Steps 3, 4, and 5 into one single step, which is the step to develop the instructional competency that promotes the mathematical process skills. Then the single step is divided further into four sub-steps, which are (1) sub-step 1 (design of the development of instructional competency), (2) sub-step 2 (develop the instructional competency according to the plan), (3) sub-step 3 (check, review the results of the development on instructional competency), and (4) sub-step 4 (reflect the results of the development on instructional competency). Besides, the combination of Steps 6 and 7 into one single step, which is the step on the evaluation and reflection of the results of the development, is done because the data reflection immediately after evaluation will help to improve the efficiency.

2) Adjustment of the implementation of the target group teachers according to the model of development, which is identified previously into seven Steps (shown in

Figure 8, page 79), is simplified into six steps (shown in Figure 15, page 116). Combining the Steps 6 and 7 together, which are exchanging the learning and summarizing of the knowledge, is possible because the exchanging of learning can be implemented at the same time with the recording/summarizing of the gained knowledge.

The researcher's role as a facilitator of knowledge management will highly affect the implementation of the target group teachers especially during the meetings for the learning exchange in the earlier period. The researcher improves the techniques or methods to encourage the learning exchange climate that the target group teachers openly and maximally share their Tacit Knowledge. These encouragement takes in many forms, for example, creation of an informal and relaxed climate, stimulation for presentation by the teachers with pride, critical analysis through self-evaluation, identification of the targets and guidelines for self-development, implementation of the gained knowledge into practice, and sharing of knowledge through "Story-telling" activities.

### **Target Groups of the Research**

1. The target group teachers in the content-areas of mathematics for Prathom Suksa 6 level in the schools under the Office of Chiang Mai Education Service Area 2 in the year 2007 are eight teachers from eight schools in four districts which are Mae Rim, San Sai, Prao, and Mae Taeng. These teachers are selected according to their qualifications identified by the researcher, Shown in Steps 3 sequence 1) Page 78.

2. Prathom Suksa 6 students who study with the selected target group teachers in second semester in the year 2007 with the total number of 185 students.

### **Tools Used in the Research**

This research has identified the tools for data collection in the research according to the objectives of the research as the followings.

 Table 1
 Analysis of the Tools Used for Data Collection in the Research

<b>Objectives of Research</b>	Tools for Data Collection in Research
1. Create the model of developing	- Record of implementation data according to
instructional competency promoting	the created model, record problems and
mathematical process skills of Prathom	obstacles in the implementation in each of the
Suksa 6 students by using Knowledge	steps and record the development improve the
Management and Action Research	implementation in each step along with the

<b>Objectives of Research</b>	Tools Used for Data Collection in Research	
	observation and interviews.	
2. Study the teachers' instructional	2.1 Evaluation form of instructional	
competency that promotes	competency promoting mathematical process	
mathematical process skills of Prathom	skills	
Suksa 6 students by using Knowledge	2.2 Record form on interviews on target group	
Management and Action Research	teachers	
	2.3 Record forms on tracing the exercises or	
	tasks of the students.	
	2.4 Evaluation form of the teaching plan	
	2.5 Record form on reflection data after	
	teaching	
	2.6 Report form on classroom	
	implementation	
	2.7 The evaluation form on students'	
	mathematical process skills	
3. Study the teachers' opinions toward	- Questionnaires to ask target group teachers'	
the model of development for	opinion and opinions toward the model of the	
instructional competency	development on instructional competency	

### Creation of Research Tools and Improvement for their Quality

The researcher creates and seeks for quality of the tools used for data collection in the research according to the types of the tools as what follows.

## 1) Evaluation Forms for the Instructional Competency Promoting

**Mathematical Process Skills** (see Appendix D, page 138-139) with the steps of creating and seeking for research tools with quality are explained below.

1.1 Study the standards, indicators, and criteria of the instructional competency that promotes the mathematical process skills created by the researcher and the target group teachers.

1.2 Identify the items to be put under the list of evaluation from the indicators of each standard by considering the indicators that can be observed and evaluated from the behavior of the teachers' teaching and learning arrangement in the classrooms. The produced list of evaluation has eight items to evaluate.

1.3 Identify the quality levels into four levels, which are "very good," "good," "moderate," and "need improvement", and identify the criteria of quality in each level as identified in Step 3 of the research implementation.

1.4 Prior check for the completeness of the statement wording in each item by the researcher and the target group teachers, especially on the validity and the clarity of the language before making revisions.

1.5 Ask assistance from five experts to check the Content Validity and Construct Validity. They also check the clarity of the language use by checking the value of Index of Item – Objective Congruence or IOC. The criteria for considering the items according to their values of IOC are given as what follows:

The items under the list of evaluation with the IOC values standing between 0.50 and 1.00 are selected and can be used.

The items under the list of evaluation items with the values of IOC standing lower than 0.50 are considered as "need improvement" or removed altogether.

Formula: IOC = 
$$\frac{R}{N}$$

IOC represents the Index of Item - Objective Congruence

R represents total of score of opinion of the experts

N represents the number of experts

The identification of the scoring criteria of the experts is as the followings.

+ 1 sure that the concerned item under the list of evaluation is consistent with the indicators and standards that require evaluation and measure directly to the character concerned.

0 not sure that the list of evaluation is consistent with the indicators and standards that require evaluation and measure the character concerned.

- 1 sure that the list of evaluation is not consistent with the indicators and standards that require evaluation and does not measure the character concerned.

The items under the list of evaluation in the evaluation form that the researcher selects are those having the IOC values standing between 0.60 and 1.00.

1.6 Improve and revise the language used in the evaluation forms to measure the instructional competency that promotes the mathematical process skills then bring the improved items to gather the data.

2) The Record Form on Interview with for the Target Group Teachers about the Instructional Competency that Promotes the Mathematical Process Skills (see Appendix D page 185 -186) as the steps of creating and seeking for quality are explained as the followings.

2.1 Study the standards, indicators and criteria of the instructional competency that promotes the mathematical process skills created by the researcher and the target group teachers.

2.2 Identify the guidelines of questions in order to be used in interviews with the target group teachers individually. From the listed indicators in each standard there are 13 questions.

2.3 Bring the guidelines for the questions that will be used for the interview to consult with 5 experts to check the content validity and the construct validity by checking the value of Index of Item–Objective Congruence. The criteria use to consider the items based on their IOC values are given below.

The items under the list of evaluation with the values of IOC standing between 0.50 and 1.00 are selected to be used.

The items under the list of evaluation with the values of IOC lower than 0.5 must be classified under "need improvement" or removed from the list altogether.

For the issues for questioning in the interview forms selected by the researcher should have the IOC values standing between 0.80 and 1.00.

2.4 Adjust and correct the wording and language used in the interviews in order to get the data consistently with the contents and the structure of instructional competency that promotes the mathematical process skills.

3) The Record Form of Checking Students' Exercises or Tasks (see Appendix D, page 187) and the steps of creating and striving for research tools with quality are explained below.

3.1 Study the standards, indicators, and criteria for the instructional competency that promotes the mathematical process skills created by the researcher and the target group teachers.

3.2 Identify the issues for evaluation based on the indicators and criteria for the instructional competency. The result of this identification is seven issues to be used in checking the students' exercise.

3.3 Bring the issues for checking to solicit advice from five experts who would check the content validity and the construct validity through the Index of Item–Objective Congruence. The criteria for considering the items under the list of evaluation based on the value of IOC are given as what follows.

The items under the list of evaluation with the IOC values ranging from 0.50 to 1.00 are selected to be used.

The items under the list of evaluation with the IOC values lower than 0.50 are considered to be "need improvement" or removed out from the list altogether.

For the issues undertaken as part of the observation list that the researcher selects have the IOC values ranging from 0.80 to 1.00.

3.4 Improve and review the issues in the students' exercises checking in order to get consistent data with the contents and the structure of instructional competency that promotes the mathematical process skills.

4) The Evaluation Form on the Teaching Plan that Promotes the Mathematical Process Skills (see Appendix D, page 188-189) and there are the steps to create and strive for the quality research tools as the followings.

4.1 Study the standards, indicators and the criteria for the instructional competency promoting the mathematical process skills created by the researcher and the target group teachers.

4.2 Identify the lists of evaluation form and the indicators of each standard. There are a total of 12 items under the lists of evaluation.

4.3 Identify the quality level into four levels, which are "very good", "good", "moderate", and "need improvement" and identify the quality criteria for each level as identified in Step 3 of the research implementation.

4.4 Preliminary check of the completeness of the statements for each item designed by the researcher and the target group teachers especially on the validity and the clarity of the language before revisions are made.

4.5 Ask for advice from five experts to check the content validity, construct validity, and the clarity of language used through the measurement of the Index of Item – Objective Congruence or IOC.

The items under the list of evaluation with the IOC values between 0.50 and 1.00 are selected to be used.

The items under the list of evaluation with the IOC values lower than 0.50 are considered as "need improvement" or removed out altogether.

For the items under the lists of evaluation in the evaluation form on the teaching plan that the researcher has selected are those with the IOC values between 0.80 and 1.00.

4.6 Improve and revise the evaluation form on the plan of teaching and learning arrangement that promotes mathematical process skills and then implement it in data gathering.

5) The Record Form Used in the Research are Record Form on the Development of Instructional Competency According to Created Model, Record Form on Data Reflection after Teaching and Record Form on List of Implementation in the Classrooms of the Target Group Teachers (see Appendix D page 190-192) and the steps of creating and striving for quality tools are as the followings.

5.1 Study the model of record for after-teaching sessions, as well as the record form for the implementation report in the classroom from the related literature on the arrangement of teaching and learning mathematics. These models for data gathering methods are adjusted to the standards, indicators, and the criteria on the instructional competency created by the researcher and the target group teachers.

5.2 Identify the issues to be recorded and then the trial for the record form is presented to the target group teachers to solicit their consideration for the possibility of the record including improving or revision according to these suggestions.

5.3 Bring the revised record form to consult with the experts to check the content validity and construct validity through the IOC or Index of Item-Objective Congruence.

The items under the list of evaluation with the IOC values standing between 0.5 and 1.00 are selected to be used.

The items under the list of evaluation with the IOC values lower than 0.5 are considered as "need improvement" or removed out.

For the lists of evaluation in the evaluation form on the teaching plan that the researcher selects are those with the IOC values equal to 1.00 in all items.

5.4 Improve and revise the evaluation forms according to the suggestions of the experts.

6) The Questionnaires to Ask Opinion or Opinions of the Target Group Teachers to the Model for Developing the Instructional Competency (see Appendix D, page 183) and the steps of creating and seeking for the tools' quality are as the followings.

6.1 Study the standards, indicators and criteria on the instructional competency that promotes the mathematical process skills created by the researcher and the target group teachers.

6.2 Identify the question guidelines to use in asking opinions of the target group teachers individually. The questions have been built around four issues.

6.3 Bring the questions guidelines that will be used to five experts to check their content validity and construct validity through the calculation of the Index of Item – Objective Congruence.

The items under the list of evaluation with the IOC values ranging between 0.50 and 1.00 are selected to use.

The items under the list of evaluation with the IOC values lower than 0.50 are considered as "need improvement" or removed out.

Under the lists of questionnaire to gather the teachers' opinions or opinions selected by the researcher are those items having the IOC values ranging between 0.80 and 1.00.

6.4 Improve and revision of the question guidelines to be used in asking the questions to collect the data consistently to the contents and the structures of the instructional competency that promotes the mathematical process skills.

7) The Evaluation Form on Students' Mathematical Process Skills (see Appendix D page 183) and the researcher creates the evaluation tools for the students' levels of mathematical process skills before and after the development for the instructional competency of the teachers. There are the steps to create and strive for quality as the followings.

7.1 Study the guidelines of evaluation on the mathematical process skills from the manual of evaluation on mathematics subjects of the Institute for the Promotion of Teaching Science and Technology, Ministry of Education (2003) and the evaluation based on the learning standards according to the Basic Education Curriculum B.E 2544 (2001) of content-areas of mathematics under Division of Development and Promotion of learning measuring and evaluation, Bureau of Academic Affairs and Educational Standards, Office of the Basic Education Commission Department (2005).

7.2 Study and analyze the mathematical process skills, the learning contents of mathematics content-areas of Prathom Suksa 6 level and identify the behavior and traits that need to be measured.

7.3 Create the evaluation form on the mathematical process skills which are the test form in essays and identify the criteria for the evaluation into four levels, which are "very good", "good", "moderate", and "need improvement".

7.4 Bring the created evaluation form and evaluation criteria on the mathematical process skills to consultation with the experts to check their content and construct validities through the measurement of the Index of Item – Objective Congruence or IOC. The evaluation form and the criteria selected should have the IOC values ranging between 0.60 and 1.00.

7.5 Improve and make revision on the evaluation form and the evaluation criteria on the mathematical process skills according to the suggestions of the experts.

7.6 Bring the evaluation form for a trial with the Mathayom Suksa 1 students in San Sai Luang School in first semester year 2007 (number of students is 40). The researcher and the target group teachers are the persons who check and score the results of this trial together.

7.7 Bring the results to improve and revise the evaluation forms and present them back to the experts for another series of checks again. After that the gathered suggestions are used to improve, revision, and use in the evaluation of the students' mathematical process skills.

#### **Data Collection**

The researcher implements the data collection as the followings.

1. During the collection of the data before the development of instructional competency model, the researcher collects the data about the existing instructional competency that promotes the mathematical process skills between June 2007 and August 2007 in the following manners.

1.1 Evaluate the instructional competency from the classroom visits to those of the target group teachers by using the evaluation form on the instructional competency promoting the mathematical process skills.

1.2 Interview the target group teachers regarding their levels of instructional competency that promotes the mathematical process skills.

1.3 Evaluate the instructional competency based on the tape recorded class sessions assisted by the use of the evaluation form on the instructional competency that promotes mathematical process skills.

1.4 Evaluate the teaching and learning arrangement plan by using the evaluation form on the teaching and learning arrangement plan that potentially promotes the students' mathematical process skills.

1.5 Observe the trace of checking students' exercises assigned by the target group teachers by using the record form on checking the results of students' exercises or tasks.

1.6 Observe the results of the teaching and learning arrangement of the target group teachers form the record form after the teaching sessions.

1.7 Evaluate the students' levels of mathematical process skills by using the created test form.

2. During the implementation or trial of the model to develop the teachers' instructional competency, the researcher gathers the data on the implementation according to the plans in the created model, the recording methods of the problems and obstacles in the implementation in each step, the recording form of the improvement of the implementation in each step through the observation of the implementation, and the interviews with the teachers and students. This data is gathered between June 2007 and March 2008.

3. After the trial of the instructional competency development model has been accomplished, the researcher gathers the data about the levels instructional competency that promotes the mathematical process skills between February 2008 and March 2008.

3.1 Evaluate the instructional competency through the classroom visits of the target group teachers by using the evaluation form on the instructional competency promoting mathematical process skills.

3.2 Interviews with the target group teachers about their levels of instructional competency promoting mathematical process skills.

3.3 Evaluate the instructional competency from the recording of the teaching sessions by using the evaluation form for the instructional competency.

3.4 Evaluate the teaching and learning arrangement by using the evaluation form on the arrangement of teaching and learning that promotes the mathematical process skills.

3.5 Observe the trace of checking students' exercises assigned by the target group teachers by using the record form on tracing student's exercises and tasks.

3.6 Study the results of the teaching and learning arrangement of the target group teachers from the record form after the teaching sessions and the recorded implementation report in the classroom.

3.7 Evaluate the student s' mathematical process skills by using the test form.

3.8 Record the opinions or opinions of the target group teachers toward the model for developing the instructional competency by using the questionnaires prepared to gather opinions.

### **Data Analysis**

The researcher analyzes the data by classifying them according to the objectives and the characteristics of the research data as the followings.

# **Table 2** Analysis Methods to Research Data Classified According to the Objectives and Characteristics of Research Data

Objectives	Characteristics of	Methods to Analyze the Data
	Data	and Statistics
1. Create the model to develop	- Qualitative Data	- Data analysis from the
instructional competency		induction
2. Study the Instructional	- Quantitative Data	- Analyze the means and
Competency of the Target Group		standard deviations
Teachers		- Statistic used are
		1) Mean
		2) Standard Deviation
3. Study the Teachers' Opinion	- Qualitative Data	- Data analysis from the
toward the Model to Develop		induction
Instructional Competency		

The interpretation of the result of the study on the instructional competency of the target group teachers is undertaken according to the criteria related to average ranges as the followings.

The average lower or equal to 1.74	Means the quality level is in "Need
	improvement"
Average between 1.75 and 2.74	Means the quality level is
	"Moderate"
Average between 2.75 and 3.49	Means the quality level is "good"
Average between 3.50 and 4.00	Means the quality level is "very
	good"

(The office for National Education Standards and Quality Assessment (Public Organization), 2006 : 92)

# Target of Success in the Development of the Instructional Competency Utilized by the Created Model

All the set standards have achieved the development of the quality level in the implementation higher than the evaluation result before the development with at least one level higher.