



## Model Development of Additional Mathematics Instructional for Enhancing Analytical Thinking Process and Achievement to Sustainability of 10 Grade Students

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**Abstract:-** *The concept of mathematics is about the relationship between various features. A specific purpose aimed to model the development of additional mathematics instructional for enhancing analytical thinking process and achievement to the sustainability of 10-grade students. The collection came from the documentary study, participation action learning with school director, academic voice director, and teachers into model development, model evaluation with experts by evaluation questionnaire, using the model to instructional with 10-grade students into study the instructional efficiency following criteria as 80/80, analytical thinking ability, learning achievement by the testing, include satisfaction to instructional by questionnaire to the data. Model of additional mathematics including the process of organizing the presentation activities, social systems, response principles, and system used to support, suitability to the model of most levels, additional mathematics instructional efficiency of 88.66/89.61, analytical thinking ability, and learning achievement of after scores to higher than before was significantly different at the level of .01., and the satisfaction of most levels. Analytical thinking process to important as learning management to effectiveness.*

**Keywords:** Model; Additional Mathematics; Instructional Efficiency; Analytical Thinking Ability; Learning Achievement

### Introduction

Mathematics learning is logical reasoning with systems and formalities through an analytical thinking process from problems in various situations. An emphasis on the development of quality and complete learners to physical, mental, intellectual, and emotional (Jedaman, P., & et al., 2017; Delaney. (2003). Thai's basic education management in mathematics learning focuses on the thinking process and analytical skills from the problems in the situation that occur, as well as can be applied to changes in the globalization era of dynamically effective. (Thai's Basic Education Commission, 2019; Office of the Education Council, Ministry of Education. 2020) the development of mathematical skills is learning to know, learning to be able and practical, including the learning skills and the ability to think critically of students for building the knowledge. Model of mathematical learning management to quality and meet the objectives of the curriculum, from organizing learning processes that focus on the practice of thinking process skills, management, and coping situations as well as applying the knowledge to prevent and solve the problems, organizing activities for the students to learn of real experience by practicing for learning achievement and knowledgeable. Mc Carthy. (1985). Analytical thinking ability is one form of thinking used to look at problems by considering the problem into 3 levels which are the events, patterns of behavior, and systems structure. (Dechagup, P., 2007) When phenomena and problem situations occur, consider creating an understanding of that situation to what are the underlying causes of the situation. (Munkham, S., 2005) They consider how the underlying causal factors are connected and linked rationally. Somri, P. (2010) learning management was related to the student's academic



achievement as the concepts mathematic about the relationship between various features of model development. In research objectives have four mains this study aimed to follow:

- 1) Model development of additional mathematics instructional for enhancing analytical thinking process and achievement to the sustainability of 10-grade students.
- 2) Study the additional mathematics instructional efficiency of 10-grade students according to specified criteria of 80/80.
- 3) Study the analytical thinking ability and learning achievement of 10-grade students.
- 4) Study the satisfaction of learning management to the effectiveness of 10-grade students.

## Literature Reviews

### **Model and Efficiency of Additional Mathematics Instructional to Analytical Thinking Ability and Learning Achievement.**

The teaching model will consist of many factors including teaching objective, students, the nature of the subject matter, technology and materials that can be used, and the characteristics of teachers. Teaching technique is the use of strategies and strategies through selection and decision making. Myers, B. E., & Dyer, J. E. (2006) the formulation of teaching techniques must consider important factors in terms of subject matter, students' nature, learning nature and learning of each the students with differences and readiness, persistence and knowledge transfer. The learning will be valuable to the students only when learning is persistent with the students and can be traced to learning other as the thinking. Reinforcement helps to persist and transfer learning. (Nasrudin, H., & Azizah, U., 2010) A select appropriate teaching strategies will be effective teaching were classifying the key characteristics that define the situation of the course, concepts about the relationship between various features, developing the appropriate analytical skills to transfer the selected strategies, and the pursuit of meaningful and reliable feedback in the form of empirical data and effective conclusions. (Pianchob, S., & Intramporn, S., 2008; Saengchan, P. (2016) in a learning management process that adheres to students and conceptual development of teaching operation model that has been organized systematically consistent with the theories and principles of learning management that can help learners learn according to the goals. Instructional to students' behavior of teaching and learning to focus on the behavior that the learners, it is very important that teachers have to consider the learning psychology that influences learning. The development of the teaching and learning process is at the heart of the problem. (Simsek, P., & Kabapinar, F., 2010) How to teach the most effective, and enable each student to learn and develop as much as possible according to their potential. Jedaman, P., & et al. (2017) said to the development of the learning process requires planning for organizing learning activities and promoting teaching and learning management to maximize benefits. Model development of additional mathematics instruction is the transfer of knowledge ideas and experiences from the teacher to the learner, in this regard, based on beliefs and theories about learning management that adhere to learners in the dimensions of teaching and learning management, consisting of the process of organizing the presentation activities, social systems, response principles, and system used to support. The efficiency of additional mathematics instructional, also, Phromwong, C. (2006) established the criteria for finding efficiency by evaluating learners' behavior in continuous behavior and final behavior. By configuring the efficiency of the process and the efficiency of the results. Normally, the criteria ( $E_1/E_2$ ) were determined based on the content of teaching and learning that is consistent with the nature of that subject. In the additional mathematics instructional efficiency of 10-grade students according to specified criteria of 80/80. Analytical thinking ability is the search for meaning from the use of intellect and understanding with the introduction of new knowledge combined with existing knowledge or experience to find answers to create new knowledge (Dechagup, P., 2007). Kemp & Deltan. (1985) analytical thinking is mindsets conditions by being open-minded. Which will help to get a reasonable and realistic conclusion throughout the working a cognitive system for leading the behaviors of



responses and situations. achievement It is a measure and evaluation according to the objectives set by the teacher. both in terms of knowledge, intelligence, and process skills. (Busayama, M., 2010) The measuring achievement is an essential aspect of teaching and learning, which determines the improvement of student success after the course has ended, and is also used as the feedback to improve teaching and learning.

## Methodology

**Research Type:** In methodology were research and development via participation action learning and classroom research to focus on model development of additional mathematics instructional for enhancing analytical thinking process and achievement to the sustainability of 10-grade students, the additional mathematics instructional efficiency according to specified criteria of 80/80, the analytical thinking ability and learning achievement, and the satisfaction on learning management to effectiveness.

**Participants:** The participants in model development were the school director, academic voice director, and teachers in Chumphaesuksa school, Thailand, a total of 10 persons, the experts of education in model evaluation, totals of 9 persons, and 10-grade students in Chumphaesuksa school of a using the model of additional mathematics instructional for enhancing analytical thinking process and achievement to sustainability, totals of 115 persons, The participants they all were by purposive sampling.

### Instruments:

1. Suitability evaluation questionnaire into 4<sup>th</sup> aspects such as (1) principles and clarifying model of mathematic instructional, (2) reason and importance on the model of mathematic instructional, (3) concepts can be used as a base for development, and (4) factors to the model of mathematic instructional of 5 rating scales have to item of objective congruence and confidence value of 0.86.

2. Learning management innovation plans in additional mathematics in 2 learning units of (1) exponential and logarithmic functions, and (2) analytical geometry and conic sections have to item of objective congruence

3. Mathematical thinking and achievement tests are multiple-choice, have to item difficulty of 0.20 – 0.80, and item discriminating power of 0.20 and above, including confidence values of 0.87, 0.89, respectively.

4. Satisfaction questionnaire into 4<sup>th</sup> aspects such as (1) efficiency of model, (2) knowledge contents, (3) applying in learning management, and (5) enhancing sustainability analysis thinking and achievement of 5 rating scales have to item of objective congruence and confidence value of 0.84.

**Collections Method:** The respondents were asked to respond to data collections. Step1 analyzed the documentary and participatory action learning with the school director, academic voice director, and teachers for model development, using the information obtained to synthesize and draw conclusions to the model, adopt a synthetic model, along with a suitability evaluation questionnaire as given to the experts to assess the model suitability. Step 2 uses the model for instructional via Learning management innovation plans in additional mathematics in 2 learning units; (1) exponential and logarithmic functions, and (2) analytical geometry and conic sections with 10-grade students, by Before teaching and learning of testing mathematical analytical thinking and achievements of the tests and recorded as grades before studying, implemented teaching and learning management, where during each unit the scores during the course were recorded as the process efficiency ( $E_1$ ), after teaching management, every unit was tested after studying, recorded as scores after classes. and achievement scores were recorded as outcome efficiency scores ( $E_2$ ), and the test scores were compared between pre-and post-study scores to determine the difference. Step 3 uses the Satisfaction questionnaire to the students as opinions to study the satisfaction levels in the data.

**Inquiries Method:** The inquiries method of data analysis on the results to a model of additional mathematics instructional was analyzed by content analysis, suitability to model, and satisfaction levels



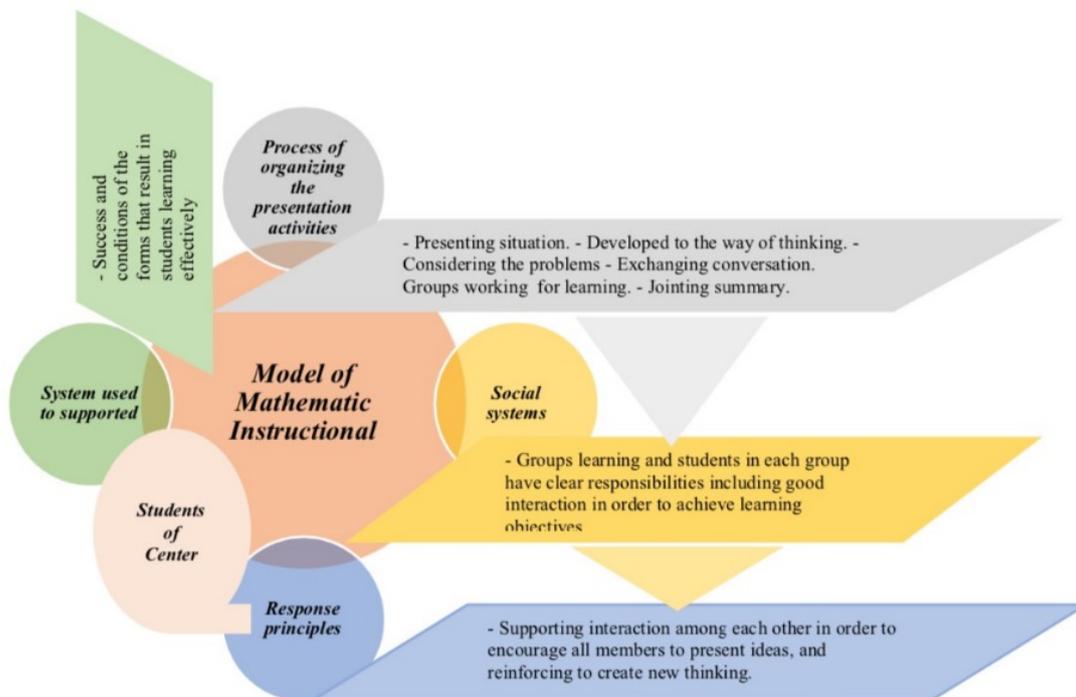
to analyzed by mean, and standard deviation, additional mathematics instructional efficiency to analyzed by percentage according to specified criteria of 80/80, the analytical thinking ability and learning achievement to analyzed by percentage, mean, and standard deviation, and t-test by a computer program.

## Majors Findings

The major's findings the results were followed:

### A. Results to the model of additional mathematics instruction.

Model of additional mathematics instructional on the factors including the process of organizing the presentation activities in 6<sup>th</sup> steps, social systems, response principles, and system used to support to shown as figure 1.



**Figure 1:** Model of additional mathematics instructional

### Process of Organizing the Presentation Activities.

1. Presenting the situation that is the problem that caused the conflict of the problem to stimulate and motivate students to have thought.

2. Developed a way of thinking to encourage students to search for information to respond to intellectual conflicts of reasonable answers, and is a response with information for bringing it to mind mapping.

3. Considering the problems to encourage students to have experience by thinking and learning by themselves, able to identify and identify the causal factors, write relationships between factors that can be designed. As well as writing the circuit causing the problem.

4. Exchanging conversation is to encourage students to talk and share knowledge with friends in small groups for each person to have the opportunity to present their work of thinking to friends and help each other to express their opinions to find a conclusion which is the resolution of the group.

5. Groups working for learning to encourage students to present their group thinking to a large group meeting, each sub-group will have to send a representative to report the conclusion and the results of the subgroup. Which will help create a new dimension of perspective.

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6. Jointing summary is a discussion and summary of both the content and concepts obtained from the results of the idea. The academic results that students have discovered, it is correct, and confident that in the future students can learn by themselves.

**Social Systems:** Social systems of the teachers must prepare the situation and questions as well as problem-solving methods, that will be used for students to practice skills. Is a creating experience for students by having to learn together as a group, each person has responsibility, and good interaction to achieve learning goals? By using social skills and group work processes.

**Response Principles:** Response principles during the activities, teaching, and learning must try to promote interaction of each other within the group and encourage all members to express their opinions and courage to speak and do what will benefit the members of the group. Teachers will provide support to help when needed, and provide continuous reinforcement.

**System Used to Supported:** The system is used to support to must to the preparation questions and prepare teaching materials to be ready and sufficient, creating a good learning atmosphere together.

**B) Results to suitability to model additional mathematics instructional.**

Suitability to the model of additional mathematics instructional into 4<sup>th</sup> aspects including principles and clarifying model of mathematic instructional, reason and importance on the model of mathematic instructional, concepts can be used as a base for development, and factors to the model of mathematic instructional of the levels to shown as table 1.

**Table 1** Mean, standard deviation., and suitability to the model of levels.

Suitability to model	Levels		Meaning
	Mean	S.D.	
1. Principles and clarifying model of mathematic instructional	4.55	0.45	Most
2. Reason and importance of the model of mathematic instructional	4.53	0.47	Most
3. Concepts can be used as a base for the development	4.57	0.43	Most
4. Factors to the model of mathematic instructional	4.58	0.42	Most
<b>Totals</b>	<b>4.56</b>	<b>0.44</b>	<b>Most</b>

Suitability to the model of additional mathematics instructional including principles and clarifying model of mathematic instructional, reason and importance on the model of mathematic instructional, concepts can be used as a base for development, and factors to the model of mathematic instructional of most levels (Mean of 4.56, S.D. of 0.44). Which the highest mean as factors to the model of mathematic instructional (Mean of 4.58, S.D. of 0.42), inferior as concepts can be used as a base for development (Mean of 4.57, S.D. of 0.43), and principles and clarifying model of mathematic instructional (Mean of 4.55, S.D. of 0.45), respectively.

**C. Results to the additional mathematics instructional efficiency.**

Additional mathematics instructional efficiency by learning management innovation plans in additional mathematics in learning units of exponential and logarithmic functions, and analytical geometry and conic sections of 10-grade students according to specified criteria of 80/80 shown in table 2.

**Table 2.** The percentage score in process and outcome efficiencies.

Additional Mathematics Instructional Efficiency	Efficiency Scores		
	Process Efficiency	Outcome Efficiency	Criteria of 80/80
Exponential and logarithmic functions	88.72	89.61	88.72/89.61
Analytical geometry and conic sections	88.64	89.61	88.64/89.61
<b>Totals</b>	<b>88.66</b>	<b>89.61</b>	<b>88.66/89.61</b>



Additional mathematics instructional efficiency by learning management innovation plans in additional mathematics in learning units of exponential and logarithmic functions, and analytical geometry and conic sections of 10-grade students in the total's efficiencies of process efficiency of 88.66, outcome efficiency of 89.61, E1/E2 of 88.66/89.61. which is higher than the criteria of 80/80. Additional mathematics instructional to effectiveness.

#### D. Results to the analytical thinking ability.

The analytical thinking ability of 10-grade students to compare pre-and post-study scores to determine the difference by t-test to shown in table 3.

**Table 3** Scoring analytical thinking ability of mean, S.D., and t-test.

Testing	Scores		Percentages	t	Sig.
	Mean	S.D.			
Learning before	26.67	2.08	66.67	16.47**	.01
Learning after	35.21	1.36	88.02		

\*\*Statistically significant levels of 0.01.

The analytical thinking ability of 10-grade students to compare pre-and post-study scores to determine the difference by t-test, which the students after scores to higher than before was significantly different at the level of .01.

#### E. Results to learning achievement.

Learning achievement of 10-grade students to compare between pre-and post-study scores to determine the difference by t-test to shown as table 4.

**Table 4.** Scoring the learning achievement of mean, S.D., and t-test

Testing	Scores		Percentages	t	Sig.
	Mean	S.D.			
Learning before	17.51	2.22	43.77	14.17**	.01
Learning after	35.84	1.52	89.61		

\*\*Statistically significant levels of 0.01.

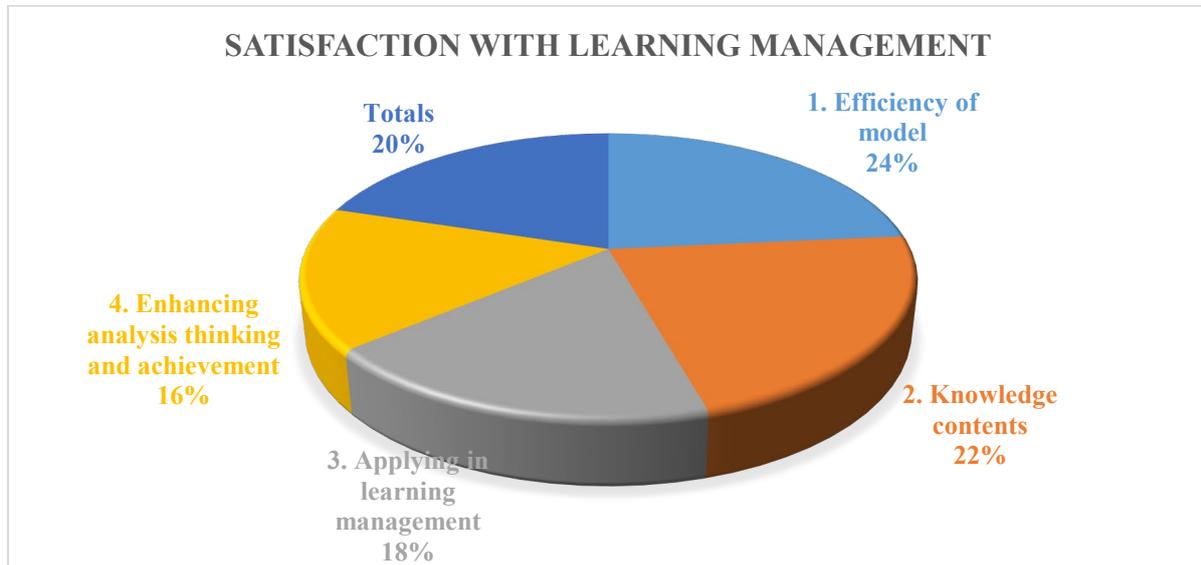
Learning achievement of 10-grade students to compare between pre-and post-study scores to determine the difference by t-test, which the students of after scores to higher than before was significantly different at the level of .01.

#### F. Results to satisfaction on learning management to effectiveness.

Satisfaction on learning management to effectiveness in 4<sup>th</sup> aspects was the efficiency of model, knowledge contents, application in learning management, and enhancing sustainability analysis thinking and achievement to shown as table 5.

**Table 5.** Mean, S.D., and satisfaction levels.

Satisfaction with Learning Management	levels		Meaning
	Mean	S.D.	
1. Efficiency of model	4.65	0.35	Most
2. Knowledge contents	4.67	0.33	Most
3. Applying in learning management	4.73	0.27	Most
4. Enhancing analysis thinking and achievement	4.76	0.24	Most
<b>Totals</b>	<b>4.70</b>	<b>0.30</b>	<b>Most</b>



Satisfaction on learning management to effectiveness in the 4<sup>th</sup> aspect was the efficiency of model, knowledge contents, application in learning management, and enhancing sustainability analysis thinking and achievement of most levels (Mean of 4.70, S.D. of 0.30). Which the highest mean as enhancing analysis thinking and achievement (Mean of 4.76, S.D. of 0.24), inferior as applying in learning management (Mean of 4.73, S.D. of 0.27), and knowledge contents (Mean of 4.67, S.D. of 0.33), respectively.

## Discussion

Model of additional mathematics including the process of organizing the presentation activities, social systems, response principles, and system used to support. Suitability to the model of most levels. Additional mathematics instructional efficiency of 88.66/89.61. Analytical thinking ability and learning achievement after scores higher than before were significantly different at a level of .01. Including the satisfaction of most levels. However analytical thinking process to important as learning management for effectiveness in creating and developing the model, there is a systematic development process under the framework of study to basic information, creating a teaching model for quality and use it systematically, which can be implemented and Promoting efficient management of mathematics as according to of Myers, B. E., & Dyer, J. E. (2006) a teaching and learning curriculum that is suitable knowledge and content to help the learners to learn according to objectives. By allowing students to respond to what they have learned And able to check one's own learning. Also, Simsek, P., & Kabapinar, F. (2010) the principles of construction must take into consideration the learners and the creators should know what level of the learners (e.g., social foundations, learning ability, original experience of the learners). The development has studied documents related to various factors that have influenced the development of teaching to be effective, including the steps for teaching from explaining the course content, the purpose of teaching and learning development, and behavioral objectives. Nasrudin, H., & Azizah, U. (2010) the development and analysis of the content prepared appropriately resulting in the learners can learn by themselves from the content that is true and stable. In the formulation of concepts and objectives that clearly indicate the importance of learning, aiming for the learners to gain knowledge based on behavioral objectives, can be observed and measured for resulting in higher students' knowledge. Learning management innovation plans are to the guidelines of teaching and learning activities, and making of the teachers ready and confident that they can manage their learning to achieve

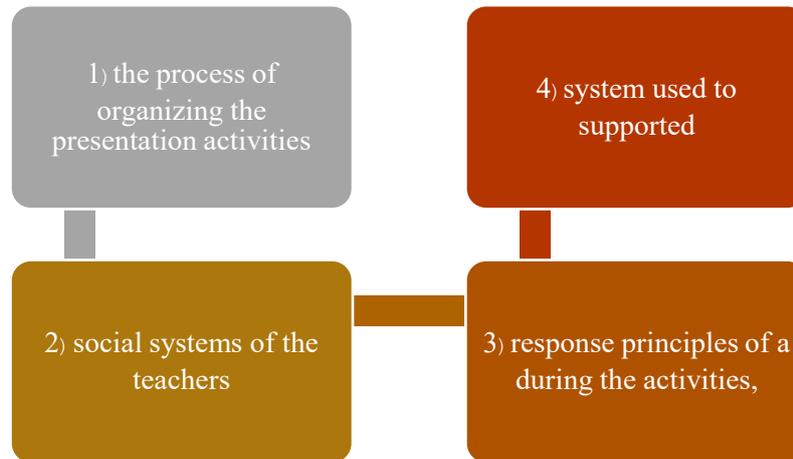
[57]



their objectives. Panasuna, R. (2011) the organization of learning activities using a learning cycle model to addition and subtraction in the results showed that learning management was the efficiency of 83.87/86.00. Process of organizing the presentation activities as a presenting situation that is the problem which caused the conflict of the problem to stimulate and motivate students have thought, developed to the way of thinking to encourage students to search for information to respond to intellectual conflicts of reasonable answers, and is a response with information for bring it to mind mapping and considering the problems to encourage of the students in according to of Supa, P. (2009) to development of learning achievement in mathematics to encourage students to have experience by thinking and learning by themselves, able to identify and identify the causal factors, write relationships between factors that can be designed. As well as writing the circuit causing the problem. Exchanging conversation is to encourage students to talk and share knowledge with friends in small groups for each person to have the opportunity to present their work of thinking to friends, and help each other to express their opinions to find a conclusion which is the resolution of the groups working for learning to encourage students to present their group thinking to a large group meeting, each sub-group will have to send a representative to report the conclusion and the results of the sub-group. This will help create a new dimension of perspective and a jointing summary is a discussion and summary of both the content and concepts obtained from the results of the idea (Khamanee, T., 2010). The academic results that students have discovered, it is correct and confident that in the future students are able to learn by themselves to effectiveness. In this regard, a model of additional mathematics instructional to the students increases knowledge and attitudes, learning capacity, and efficiency, as well as, developing strengthened learning and knowledge content make mathematical analysis abilities and academic achievement until achieving the objectives, including the satisfaction on learning management to effectiveness into the efficiency of model, knowledge contents, applying in learning management, and enhancing sustainability analysis thinking and achievement.

## Conclusion

Model of additional mathematics instructional include; 1) the process of organizing the presentation activities such as presenting situation, developed to the way of thinking, considering the problems to encourage students, exchanging conversation, groups working, and jointing summary, 2) social systems of the teachers must be preparing the situation and questions as well as problem-solving for creating experience to the students by having to learn together as a group, each person has responsibility, good interaction in order to achieve learning goals, by using social skills and group work processes, 3) response principles of a during the activities, teaching and learning must try to promote interaction of each other within the group, and encouraging all members to express their opinions and courage to speak and do what will benefit the members of the group Teachers will provide support to help, and provide continuous reinforcement, 4) system used to supported to must to the prepare questions and prepare teaching materials to be ready and sufficient, creating a good learning atmosphere together. Suitability to the model of most levels. Additional mathematics instructional efficiency of 88.66/89.61. Analytical thinking ability and learning achievement after scores higher than before were significantly different at a level of .01. Including the satisfaction of most levels. Analytical thinking process to important as learning management to effectiveness.



**Figure 2** Model of additional mathematics instruction

## Recommendation

Learning management should be understood between the students and teacher on learning process should be explained clearly and the teaching plan should be planned in a systematic and step-by-step manner. Emphasis on student-centered learning, and continuous assessment to help the students as improvements and development in effective learning.

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