

Development of Analytical Thinking Ability on Mathematics by using Learning and Enjoying Model with Mind Mapping for Pre-Service Teacher in Mathematics Program

Assoc. Prof. Dr. Yupadee Panarach

Faculty of Education, Kamphaeng Phet Rajabhat University, Thailand.
E-mail: yupadee.kpru@gmail.com

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Abstract: The purposes of this research were to study analytical thinking ability on mathematics, to compare analytical thinking ability on mathematics with the criteria, and to study collaboration, teamwork and leadership after using Learning and Enjoying Model with Mind Mapping. The samples were pre-service teachers in Mathematics program. The instrument consists of the process of Learning and Enjoying Model with Mind Mapping, the test about analytical thinking ability on mathematics, and the collaboration, teamwork and leadership questionnaire. Data analyzed by percentage, mean, standard deviation, and t-test one group. The results found that, pre-service teachers had 74.64 percent of analytical thinking ability on mathematics and it was higher than the criteria of 70 percent at .05 level of significance, when considered in each aspect found that the analysis of element had highest percent, then the analysis of relationship, and analysis of organizational principles respectively. Moreover, pre-service teachers had collaboration, teamwork and leadership as a whole at a high level. Considering that everyone willing to accept the results of their work in highest average, followed by every member is important for work success according to goal, they believe that every members of the group can work towards their goals, and all members are involved in decision-making respectively. Pre-service teachers commented, this learning process has easy steps to implement with students. Creating a Mind Mapping is connecting a content to help understand the details and whole of the contents

Keywords: Analytical Thinking Ability on Mathematics, Mind Mapping, Leadership and Teamwork, Learning and Enjoying Model

1. Introduction

Education in the 21st century must prepare people to be knowledgeable workers and to be able to learn. The key skills are learning and innovation as well as Information, Media and Technology Skills and Life and Career skills. The skills should be developed from kindergarten to university and throughout life is 3R x 8C [19], especially in tertiary education management. It should be learning in an interdisciplinary manner by enhancing knowledge and building on life skills and vocational skills. Learning by practice along with the practice of analytical thinking, problem solving and creativity and also practice communication skills and cooperation skills [1], especially cooperative skills including teamwork and leadership are one of the key skills for students to work with. Students will need to have the skills to collaborate and work with those involved. It is characterized by leadership which is able to lead the group members towards the set goals [21] and from the study of the high-performance teacher production system for Thailand 4.0 on the quality goals that must produce teachers to have desirable conditions of professional skills and teamwork skills are essential skills [8], to make learning a lifelong learning. Teaching design should focus on students' learning together and the assessment of teaching results should be assessed to cover the individual care of the students. Organizing activities and situations for students to express and think creatively as well as encouraging students to think, practice, and self-assessment to create knowledge by themselves as well as giving opportunities for students to exchange and learn from groups [11].

Analytical thinking is fundamental to all types of advanced thinking [21]. It is an in-depth idea that requires observational abilities, interpretation, querying, finding logical connections to find the subject matter involves distinguishing the elements and understanding what is happening, which leads to a straight resolution [5]. One method of learning management that helps to practice analytical thinking is the use of mind mapping to write an overview and a sub-picture of each related content showing omni-directional thinking in a way that expresses the potential of the human brain [15] in consistent with the research of, as in [13] found that after being trained to create mind maps, the students had higher overall analytical thinking ability than before, received statistically significant training at the .05 level, and the group of students who received mind mapping training had a statistically higher analytical thinking ability than the untrained group at the .05 level and in consistency with the research of, as in [17] found that listening and reading abilities captured the importance of English after studying higher than before using the mind mapping with an average of 23.10% and 20.30%, respectively. The writing and speaking aspects were presented by using a concept map, including a high level, and the results of observing students' English language learning behavior using a conceptual mapping. Overall, students were very interested in learning English; moreover, the research by, as in [4] and the research by, as in, [14] found that the students had higher post-

mathematical thinking skills than before using the fun-coupled learning process at the .05 level and their analytical thinking skills were higher than the percentage criterion. 70 was statistically significant at the .05 level, as well as the teamwork skills and work commitment after using Learning and Enjoying Model (5T Model) overall at a high level and attitudes towards mathematics were at the highest level.

Given this importance, therefore, researchers are interested in developing analytical thinking capabilities for pre-service teacher. The 5T Model is a learning management that have competitive activities between groups for fun and cognitive assessment tests, as well as the opportunity to examine knowledge, which will help learners gain a better understanding [23], together with the use of a mind mapping focused on allowing students to link the overview and details of the sub-images in the study material. In addition, students can use the group process from the beginning, namely study and research, presentation design and giving presentations by using mind mapping including learning from other groups into a learning base and organizing a group competition to give everyone the opportunity to represent the group to compete with other groups. The members of each group help one another to prepare themselves so they can score the most. In these processes, the researcher, as the teacher, believes that it improves analytical thinking abilities, cooperation, teamwork and leadership for students. These skills and traits are characteristic of 21st century people and students can use them to apply to their studies and work further.

2. Research Objectives

1. To study of analytical thinking ability on mathematics after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program.

2. To compare the analytical thinking ability on mathematics after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program with criteria.

3. To study collaboration, teamwork and leadership after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program.

3. Research Hypothesis

Pre-service teachers in Mathematics program had analytical thinking ability on mathematics after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program higher than 70 percent of criteria.

4. Literature Review

A. Analytical thinking

Analytical thinking is the basis of all types of advanced thinking [21], which is the ability to consider details , categorize information Into smaller parts and organized into categories to find the truth, importance, essence, element or principle of the matter [9]. The analytical thinking consists of 3 parts [2] as follows:

1. The analysis of elements is to distinguish what is necessary, what is important and what is most important, such as type analysis , important things analysis or equivocal findings analysis.

2. The analysis of relationships is a relationship of things that are related to each other. How are they connected? How much are they related to each other? Are they Consistent or contradictory? , including analyzing types of relationships , analyzing the size of the relationship , analyzing the relationship procedures , analyzing the purpose and method , analyzing cause and effect or analyzing a relationship in a figurative form.

3. The analysis of organizational principles is the search for structures, systems, stories, things, and functions that they exist in such conditions due to some reason; for example, what's the core? How does it work? What technique or what motto? What is the link? The analysis of organizational principles is analysis that is considered the most important.

B. Learning and Enjoying Model (5T Model)

The Learning and Enjoying Model (5T Model) is a learning management model that focuses on group processes in building knowledge. There are competitive activities between groups for fun and knowledge assessment tests Including having the opportunity to examine the knowledge will help learners gain more understanding [23]. Teaching CIPPA (CIPPA Model) is a concept that focuses on the learners themselves including interaction with friends, other people and surroundings Including skills and processes to be used to create knowledge and appropriate physical movement [16] together with the concept of student teams achievement divisions (STAD) that focuses on motivating learners to help fellow group members learn and recognize the importance of learning and have fun learning. This is because a group will succeed only when all members learn. The group score is derived from the

development score of all group members for each exam. The learner's responsibility is to explain the knowledge to peers [10], and teaching and learning in a competitive group (Team Game Tournament: TGT) that focuses on learning for students to help friends in the group to learn to give students an equal chance of success. The group score will be derived from individual scores. This will increase the excitement and interest in learning as all group members have to prepare for the competition by helping explain to friends [10]. This process of Learning and Enjoying Model (5T Model) consisting of 5 steps as follows:

T: Teach means teaching is a review of knowledge and may be content that has been studied before or other related content which is the basis for learning new material. The teacher is the instructor.

T: Team means organizing learning activities as a group by dividing the students into groups of 3-4 people, each group together to study the new content from the teacher prepared or from various knowledge sources until everyone has a common understanding.

T: Tournament means competition is a competition between groups by having each group send a representative to answer questions and the teacher prepares questions equal to the number of groups to give every representative group the opportunity to answer first.

T: Test means to test each learner to do a test prepared by the teacher.

T: To build confident, means building confidence. Let the students alternate as exam examiners by teachers and students together to answer the test including providing points for correct answers along with ways to find wrong answers. After that, total points will be combined and compliment will be given to learners with the highest scores together with encouraging students with lower grades.

C. Mind Mapping

A mind map is a diagram that shows omni-directional thinking which is the natural behavior of the human brain and powerful visual expression which leads to the universal key to unlocking the potential of the brain. Mind mappings apply to all aspects of life. This enables improved learning and clearer thinking for the development of human actions [15]. The mind mapping also has four main characteristics as follows:

1. Subject of interest which will be built in the middle of the diagram.
2. The main topic of the subject is centered out in all directions, as if a branch of a tree branched out.
3. Branches branching out include an image or a word written on a line that links together. The other words that are important are written down on a limb that broke out in the order in the next order.
4. Branches will be linked in different ways depending on the location and importance of the issues.

D. Cooperation, teamwork, and leadership

The 21st century skills that everyone will learn throughout their lives are 3R x 8C [19] and cooperation skills, collaboration, teamwork and leadership are the fourth skill of the 8C, the essential skills required for study, work and life by cooperation skills as a joint action and expressing enthusiasm, helping each other [22]. Teamwork means that people come together to work together with determination with the same goal: the success of the work [6] that members of the team have roles and feelings together. Within the group, roles and responsibilities are divided according to the knowledge, abilities and skills of the members [20]. Relationships with each other are interdependent traits for the success of the work as a member of the team has the same goal of doing the job that makes everyone willing to work together and ready to face any problems. Together, this results in the production of high-quality work [18] and leadership is the ability to persuade the followers to follow in order to achieve the desired goals [3].

5. Research Methods

A. Populations and Samples

The population was for pre-service teachers in Mathematics program during the first semester of the academic year 2018 in 3 groups of 82 students, the sample consisted of 29 people that were obtained by cluster random sampling.

B. Research Instruments

The research instruments included:

1. The processes of Learning and Enjoying Model with Mind Mapping is learning activities that focused on the group process of organizing knowledge systems and linked knowledge of ideas and then conveyed them on paper using lines, colors, or images as links and learning all content using the learning base, and then have competitive

activities between groups and knowledge monitoring to help students gain a better understanding. It was divided into 6 stages as follows:

Step 1: Organizing a team: students were divided into 5 groups and they were given draws to learn mathematics such as numbers and operations, measurements, algebra, geometry, probability and statistics. Each group jointly plans and divides their duties and responsibilities.

Step 2: Education and research: each group studied mathematical vocabulary and meaning of English vocabulary which was divided into primary and secondary levels in the subject of learning that was assigned and designed a presentation of vocabulary, mathematics and meaning by using mind maps separated by level.

Step 3: Presentation: each group presented vocabulary according to the designed mind map at the elementary level and secondary by requiring everyone in the group to participate as presenters.

Step 4: Group learning: each group learned mathematical vocabulary and meaning of English vocabulary by finding ways or methods to allow all members of the group to learn as much vocabulary as possible and circulate in every subject to learn the vocabulary of every group, which was a learning base. Entering the learning base could begin to learn in any subject matter.

Step 5: Competition: organize exams on mathematical vocabulary and the meaning of English vocabulary. Each group clearly defined the order of representation to answer the member's questions in order for everyone to have the opportunity to take the highest score test for the group, as the number of points in each verse was not the same but the sum of all scores was the same. The competition was held in two rounds: elementary and secondary.

Step 6: Appreciation: students were asked to share exams and scores for the right answer groups, given some compliments to the highest-scoring groups, and encourage lower-scoring groups.

2. The analytical thinking ability on mathematics test: it was a 45-items with 3 parts as follows: analysis of elements, analysis of relationships, and analysis of organizational principles. The validity analyzed by index of item – objective congruence (IOC) between 0.67 to 1.00, reliability analyzed by Kuder-Richardson 20 (KR-20) was 0.89, difficulty value (p) between 0.39 to 0.79, and discrimination value (r) between 0.21 to 0.57.

3. The collaboration, teamwork and leadership questionnaire which was validity analyzed by index of item – objective congruence (IOC) between 0.67 to 1.00, and reliability analyzed by Conbach's Alpha was 0.87.

C. Data collection

1. Organize learning by Learning and Enjoying Model with Mind Mapping in 6 steps which was conducted 2 rounds for the Mathematics content in elementary and secondary education levels.

2. The pre-service teachers did the analytical thinking ability on mathematics test, and collaboration, teamwork and leadership questionnaire.

3. The pre-service teachers participated in exchanging, learning and discussing the learning process and apply it to the management of learning with the students in the future.

D. Data Analysis

1. The study of analytical thinking ability on mathematics, and collaboration, teamwork and leadership after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program. The analysis was done by percentage, mean and standard deviation.

2. The comparison of analytical thinking ability on mathematics after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program with criteria analyzed by t-test one group.

6. Results

1. Pre-service teachers had analytical thinking ability on mathematics overall accounted for 74.64 percent. When considering each aspect, it was found that they had analysis of elements at the highest level accounted for 80.67 percent, followed by the analysis of relationships accounted for 74.27 percent and the ability to analysis of organizational principles representing 68.93%, respectively, found the results as in Table I.

2. Pre-service teachers had analytical thinking ability on mathematics after using Learning and Enjoying Model with Mind Mapping was significantly higher than the criterion of 70% at the .05 level as shown in Table II.

3. The study of collaboration, teamwork and leadership of pre-service teachers in Mathematics program found that for pre-service teachers had cooperation, teamwork and leadership. The overall was at a high level. When

considered individually, it was found that everyone willingly accepted the results of their work. There was the highest average, followed by every member was essential to accomplish the goal and students believed that all group members could work towards their goals. The group members discussed each other using the reasons for achieving their goals in order of results as shown in Table III.

Table I Mean (\bar{X}), standard deviation (S.D.), and percentage of analytical thinking ability on mathematics after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program.

The analytical thinking ability on mathematics	score	\bar{X}	S.D.	percent
analysis of elements	15	12.10	2.06	80.67
analysis of relationships	15	11.14	2.56	74.27
analysis of organizational principles	15	10.34	2.14	68.93
Total	45	33.59	5.26	74.64

Table II The results of comparing the analytical thinking ability on mathematics after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program with a 70 percent criterion

	μ	\bar{X}	S.D.	t	Sig.
the ability of mathematics analytical thinking	31.50	33.59	5.26	2.135	.042

p < .05

Table III show the mean (\bar{X}) standard deviation (S.D.) of the collaboration, teamwork and leadership after using Learning and Enjoying Model with Mind Mapping for pre-service teachers in Mathematics program.

Collaboration, teamwork and leadership	\bar{X}	S.D.	Meaning
1. All members planned to work.	4.34	0.55	High
2. The division of duties and responsibilities in the group was clear.	4.17	0.71	High
3. All members cooperated in the work.	4.21	0.68	High
4. Students accepted the opinions of the members of the group.	4.41	0.50	High
5. While working together, there was talk, exchange ideas with members.	4.24	0.83	High
6. Students could make suggestions to group members.	4.17	0.76	High
7. Students were assigned to work in full capacity.	4.10	0.67	High
8. Students believed that group members can achieve their goals.	4.48	0.69	High
9. Students accepted opinions or suggestions from the group.	4.38	0.73	High
10. Every member is the key to achieve the goal.	4.52	0.83	Highest
11. All the students took part in the decision.	4.48	0.63	High
12. Everyone willingly accepted the results of their work.	4.55	0.57	Highest
Total	4.34	0.69	High

7. Discussion

The discussion of the research results is divided into 2 issues: development of analytical thinking ability on mathematics, and collaboration, teamwork and leadership are as follows:

1. The pre-service teachers in Mathematics program had analytical thinking ability on mathematics after using Learning and Enjoying Model with Mind Mapping, accounted for 74.64 percent and 70 percent higher than the threshold, statistically significant at the .05. The results were due to learning management by using a fun paired learning process combined with mind mapping, starting from organizing a team, sharing responsibility to study, research and bring results to exchange and learn in the group and jointly design a presentation using a mind mapping. Then, it was a presentation to share and learn with friends. Also, in the learning process as a group, each group needed to find a way to learn and understand all of the content in order to prepare knowledge for the next stage of the competition and at the competition stage, there were not equal ratings for each item. All members of the group had the opportunity to represent the group in competing with the most points, so everyone would be determined so as not to upset the group. The results were consistent with the research of, as in [13] found that after being trained to create a mind map, students had higher analytical ability both side and overall than before, having been statistically significantly trained at .05 and the research of, as in [12] found that the latter was managed to learn using problems as a base for combining concept mapping techniques. The pre-service teachers achieved statistically significantly higher academic achievements at .05 and research on the concept of a fun coupling with learning management process [23]. Research found by as in [4], [14] found that students had higher mathematical critical skills before using the fun learning process statistically significant at .05 and with post-use critical thinking skills, the fun coupling with learning process was above the threshold. It was statistically significant at .05 and also

included research by, as in [7] that studied the results of using mind mapping to develop mathematical and scientific skills by studying with students aged 4-5 years, mathematical skills were grouping, matching, comparison and sorting including counting thinking about geometry measurement and presentation of information forms and relationships and problem solving through deductive reasoning and the use of basic scientific instruments. The research results were found that students prepared and connected knowledge using higher levels of skills and also found that the use of mind maps could be applied in daily life. It also promoted development in childhood, which was an important method for children to adopt.

2. The pre-service teachers in Mathematics program had high collaboration, teamwork and leadership overall due to the stages of Learning and Enjoying Model with Mind Mapping. It was a learning activity that focused on the group process of organizing knowledge systems. Everyone was responsible for the group's assignment to study and exchange knowledge in the group as well as organizing knowledge systems together. Each person had to explain the tasks they had been assigned, participated in group presentations in the presentation stage, and found ways for group members to learn as much from other groups as possible. It also played an important part in representing the competition between the groups which had to take the most points for the group, so everyone was eager to cooperate with each other [22] to get the job done [6]. Listening to and commenting with the group resulted in the production of high-quality works [18], in line with which the concept of learning management process was applied to the fun couple [23]. The results were in line with research by, as in [4] and [14] found that after using the learning process coupling with fun, teamwork skills of students were very high.

Recommendations

Recommendations for Practices

The processes of Learning and Enjoying Model with Mind Mapping should be prepare the period of time for each step are difference according to the contents.

Recommendations for Further Research

From the advantages of this learning model, interested person should study the analytical thinking ability on mathematics with the mathematics skills such as: communication and presentation in mathematics, and connecting mathematical ideas to other concepts and to other disciplines.

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