Integrating Mind Map in PBL Activities on Variation to Promote Analytical Thinking Skills

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Abstract

Analytical thinking is considered as higher order thinking and more important than that, analytical thinking is considered as the basic of all kind of thinking that has an influence in human learning and living in daily life. However because of abstract form of thinking, finding the way to move it from abstract to concrete becomes a key successful in learning design. The purpose of this study is to develop learning activities using PBL with integrating mind map as a scaffolding tool applied for supporting students to present analytical thinking skills in concrete form simultaneously with motivating it by problem solving process on Variation. To determine the effect of using learning activities based on PBL with integrating mind map on the levels of students' analytical thinking skills, three subjective tests about subject matter on Variation are administered as posttest to student. The rubric score is employed to determine the level of students' analytical thinking skills through their performing in subjective tests. Data from rubric for evaluating student' analytical thinking skills is analyzed using descriptive statistics to find frequency of students identifying particular student' skill levels in analytical thinking for each of essential features of analytical thinking skills and to compute the mean skill levels in analytical thinking of students for each essential features. The results have verified the significant effect that learning activities using PBL with integrating mind map have an effect on students' analytical thinking skills.

Keywords: Analytical Thinking Skills, Mind Map, Problem Based Learning, Problem Solving, Variation

Introduction

Analytical thinking is considered as higher order thinking and more important than that, analytical thinking is considered as the basic of all kind of thinking. By this reason, analytical thinking has an influence in human learning and living in daily life and analytical thinking of human is able to develop and improve for increasing potential by various methods that related with training skills of analytical thinking (Heong et al., 2011; Nayef, Rosila, Yaacob & Ismail, 2013).

One crucial activity in mathematics learning that can train students in analytical thinking skills is problem solving because students learn to solve problems simultaneously with thinking analytically. By this reason, every time encourage students in problem solving as well as encourage them in analytical thinking (Hmelo-Silver, 2004). However, because of abstract form of thinking, it is quite hard to know what students think and its significant results in problem solving; moreover, direction of training skills of analytical thinking is not apparent followed by skills needed in developing. This disadvantage has an effect on the successful of students' learning in long term because students cannot analyze important information and condition from given problem situations. At this point, finding the way to move analytical thinking from abstract to concrete is very helpful in training students to improve analytical thinking skills in expected direction (Takahashi & Meguro, 2005; Areesophonpichet, 2013).

Mind map is considered as a scaffolding tool to support students to transfer what they think into concrete form through constructing mind map (Brinkman, 2003; Radix & Abdool, 2013; Rochmad, 2014). Instructor

can design instructional sequence and instructional materials to train students in skills of any kind of thinking especially analytical thinking skills for our goal by assigning mind map construction during problem solving. Students will practice their analytical thinking skills concretely from constructing mind map in problem solving process (Takahashi & Meguro, 2005; Areesophonpichet, 2013).

This study was designed to investigate the effect of integrating mind map to create learning activities using PBL on Variation. Each activity was designed to train student to perform analytical thinking skills through constructing mind map to find procedures to solution of mathematics problem related to subject matter about Variation. The results were wishful to be observed is that the evidence of analytical thinking skills from mind map and subjective tests.

Key Concept of Learning Design Using PBL with Integrating Mind Map

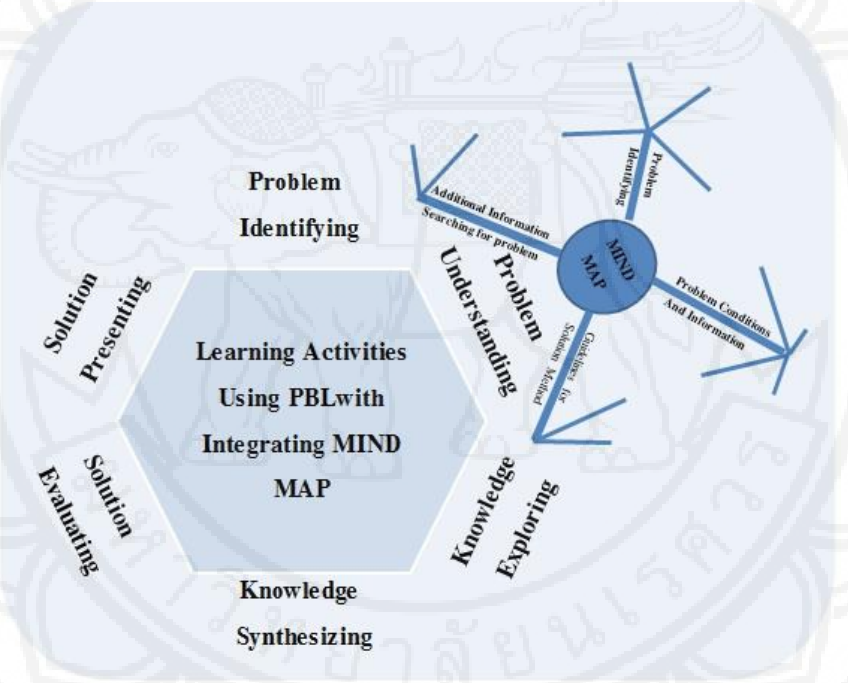

Figure 1 Key concept of learning design with integrating MIND MAP

For the development of mathematics learning activities using PBL with integrating mind map on Variation, Six stages of Problem-Based Learning were applied from Hmelo-Silver (2004). Mind map would be played as a scaffolding tool for support students to perform in the stage of Problem Understanding that motivated students to employ analytical thinking skills with problem situations and then they could transform their thinking into mind map construction. All of stages could be summarized in Figure1 and could be given by details of each stage as follow;

Satge 1: Problem Identifying

Problem situations would be posed for students in many forms including with video clip, narratives, and documents.

Stage 2: Problem Understanding

By using group process, students in each group were assigned to construct mind map underlying analytical thinking about problem situations including thinking

analytically about problem identifying, condition and information from problem situations, additional information needed to search for finding problem solution, and possible procedures for solving problems.

Stage 3: Knowledge Exploring

Students were suggested to use mind map like a navigator to investigate additional information related to procedure.

Stage 4: Knowledge Synthesizing

Students were in problem solving process and formulated answers to the problems

Stage 5: Solution Evaluating

Students concluded and evaluated their solution.

Stage 6: Solution Presenting

Students presented their solution from solving problems

Methodology

Participants

This study was designed to investigate the effect of integrating mind map to create learning activities on Variation. The subjects were 32 eighth grade students from Kantromwittayakom School, Sisaket Province, Thailand, in the academic year 2015.

Instruments

There were 3 lesson plans in content knowledge about Variation. Each activity was designed to support student not only to access contents knowledge about Variation but also to promote analytical thinking skills by reflecting students' thinking analytically from abstract into concrete form through constructing mind map in process of problem solving. To investigate the effect of using learning activities using PBL with integrating mind map on the levels of students' analytical thinking skills, three subjective tests about subject matter on Variation were created. The rubrics for scoring subjective tests based on essential features of analytical thinking skills related with the level of Marzano higher order thinking skills searched from Heong et al. (2011) and Bloom's taxonomies of educational objective domain searched from Nayef et al. (2013) were developed. In the rubric, each of the four essential features (classification, categorization, connection, and conclusion) was represented by four levels (emergent, developing, proficient, and exemplary), each indicating a different level of achievement of that feature.

Procedures

A total of 32 eighth grade students involved in this study were engaged in learning activities using PBL with integrating mind map on Variation. Three subjective tests about Variation were administered as posttest to students. The rubric score was employed to determine the level of students' analytical thinking skills through their performing in subjective tests.

Data Analysis

Data from rubric for evaluating student' analytical thinking skills was analyzed using descriptive statistics to find frequency of students identifying particular student' skill levels in analytical thinking for each of essential features of analytical thinking skills and to compute the mean skill levels in analytical thinking of students for each essential features.

An Example of Learning Activity Using PBL with Integrating Mind Map

Students were separated in 4 people per group by using equal ability criterion for each group. There were eight groups to perform learning activities of each learning stage hereinafter.

Stage 1: Problem Identifying

Problem situation in the figure 2 would be posed for students to inquire.

สถานการณ์ที่ 1 ปริมาณน้ำยางพารากับราคา

เมื่อ 7 ปีที่แล้ว บ้านกันทรอม ตำบลกันทรอม จังหวัดศรีสะเกษ มีโครงการจากกระทรวงเกษตรและสหกรณ์ส่งเสริมให้เกษตรกรปลูกยางพาราเป็นอาชีพ เพราะน้ำยางพารากำลังเป็นที่ต้องการของตลาดยางพาราโลก เกษตรกรรายหนึ่งสนใจปลูกยางพารา โดยก่อนปลูกได้ทำการศึกษาว่าพันธุ์ยางพาราชนิดใด ให้ปริมาณน้ำยางมากที่สุด เขาพบว่าพันธุ์ RRIM 600 เมื่อโตเต็มที่จะได้น้ำยางที่มีคุณภาพและให้ปริมาณน้ำยางมาก เขาจึงปลูกยางพาราในพื้นที่ 5 ไร่ ไร่ละ 72 ต้น ในปี 2556 เป็นปีแรกที่เขาได้กรีดยาง เขาพบว่า ความสัมพันธ์ระหว่างปริมาณน้ำยางพารากับราคายางพาราดังตาราง

พื้นที่ปลูกยางพารา (ไร่)	1	2	3	4
ปริมาณน้ำยางพาราเฉลี่ย (ก.ก./ไร่)	10	20	30	40
ราคายางพาราสด (บาท/กิโลกรัม)	360	720	1,080	1,440

จากตารางความสัมพันธ์ข้างต้นให้นักเรียนตอบคำถามต่อไปนี้

1. ราคายางพาราแปรผันโดยตรงกับปริมาณน้ำยางพาราหรือไม่
2. อัตราส่วนระหว่างราคายางพาราสดกับปริมาณน้ำยางพาราเป็นเท่าใด
3. สมการของการแปรผันของราคายางพารากับปริมาณน้ำยางพาราเป็นอย่างไร
4. ถ้าผลิตปริมาณน้ำยางพาราได้ 960 กิโลกรัมต่อครั้ง จะขายน้ำยางพาราสดได้ราคาครั้งละเท่าใด
5. ถ้าปริมาณน้ำยางพาราเป็น $\frac{1}{3}$ เท่าของปริมาณเดิม ราคายางพาราสดจะเป็นกี่เท่าของราคาเดิม

Figure 2 Problem situation about a quantity of rubber and its price

Stage 2: Problem Understanding

By using group process, students in each group were assigned to construct mind map underlying analytical thinking about problem situations including thinking analytically about problem identifying, condition and information from problem situations, additional information needed to search for finding problem solution, and gather information to formulate procedure for solving problems (see figure 3).

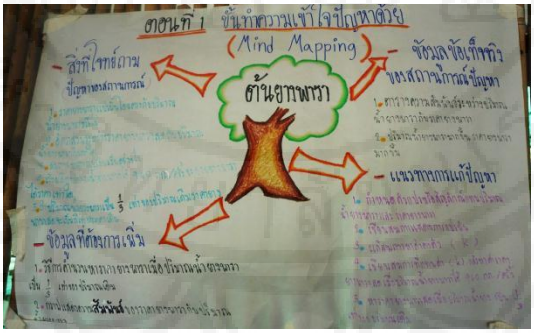

Figure 3 An example of mind mapping from student's construction in the Stage 2 (Problem Understanding) of PBL.

Figure 3 could be separated based on student' performing in analytical thinking skills in problem solving.

Figure 4 showed that students think analytically with problem identifying and they could identify five issues from problems and represented with mind map such as does rubber price have direct variation with its quantity?, what is the ratio of raw rubber price and rubber milk quantity?, what is the kind of equations of variation in this situation? and so on.

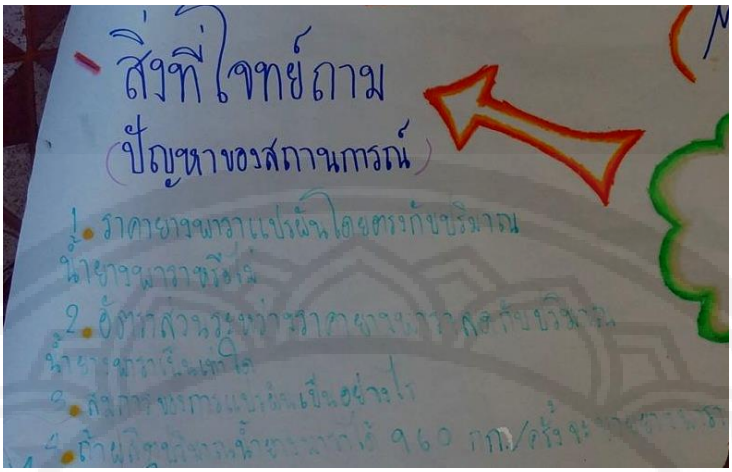

Figure 4 Students' mind map related with performing analytical thinking skill in problem identifying.

Figure 5 showed that students think analytically with condition and information given by problem situations and students demonstrate their thinking in their mind map including the relationship table between rubber quantity and its price and the information about relationship said that rubber price increase when its quantity increase.

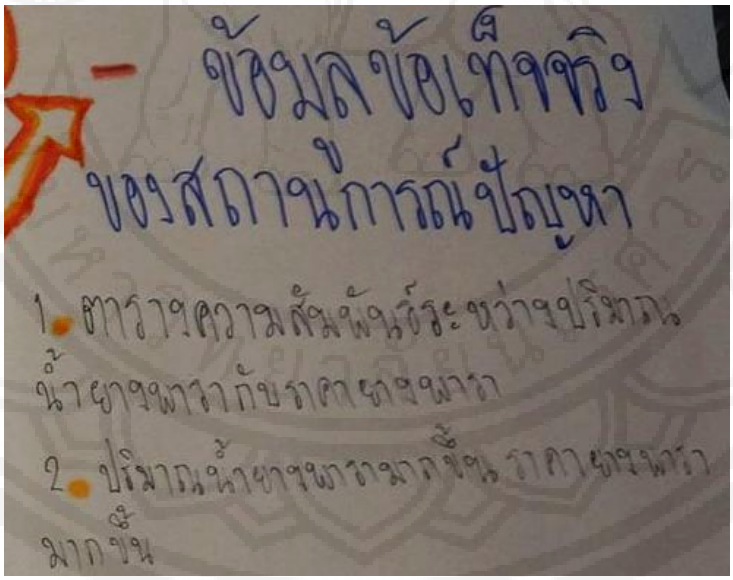

Figure 5 Mind map of student' thinking analytically with condition and information of problem situation

Figure 6 showed that students think analytically with additional information needed to search for finding problem solution and students demonstrate their thinking in their mind map including the procedure to compute rubber price when rubber milk quantity change to 1 / 3 of initial quantity and the graph representing relationship between rubber price and its quantity. They would use this part of mind map like a navigator for their searching in Stage 3 (Knowledge Exploring).

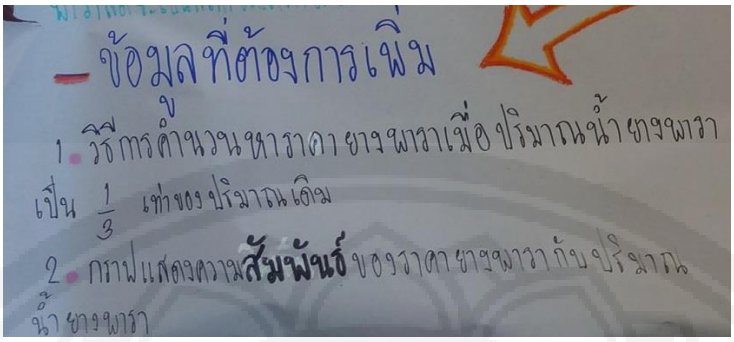

Figure 6 Mind map of student' thinking analytically with additional information needed to search for finding problem solution

Figure 7 showed that students think analytically with possible procedure for solving problems and students demonstrate their thinking in their mind map such as defending the involved variables and mathematical symbolic, presenting variation equation, solving for the constant k in variation equation, and so on. They would use this part of mind map with information from Stage 3 (Knowledge Exploring) to synthesize important knowledge for formulating procedure for finding solutions of the problems in Stage 4 (Knowledge Synthesizing).

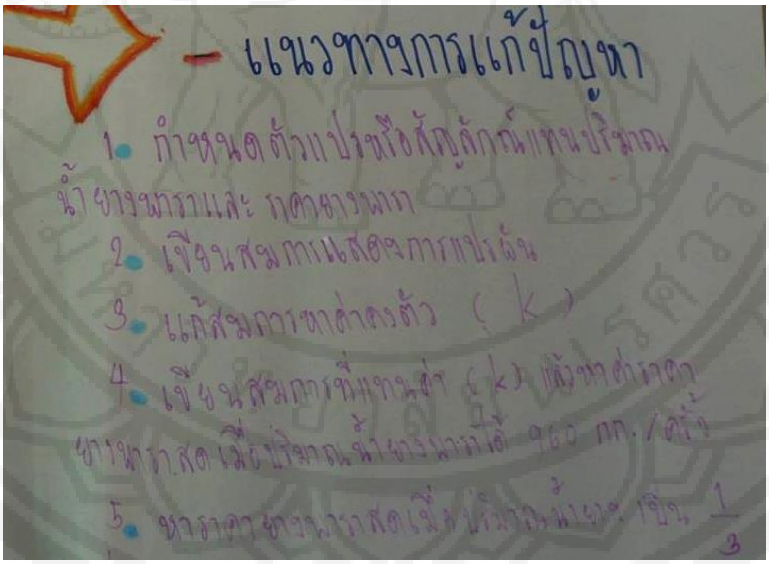

Figure 7 Mind map of student' thinking analytically with possible procedures for solving problems

After finished with stage of constructing mind map, students would be led to the next stage of learning until in the Stage 6 that they would present their learning outcome and instructor would give additional information for completing conceptual knowledge. Some atmosphere of classroom learning was presented in figure 8.

Figure 8 Some atmosphere in classroom of learning activity using PBL with integrating mind map

Analytical Thinking Skills from Learning Using PBL with Integrating Mind Map

The observation of students' learning outcome from the support of learning activities on their analytical thinking skills to accomplish problem solving would be determined by three subjective tests after the instructional sequence had been finished.

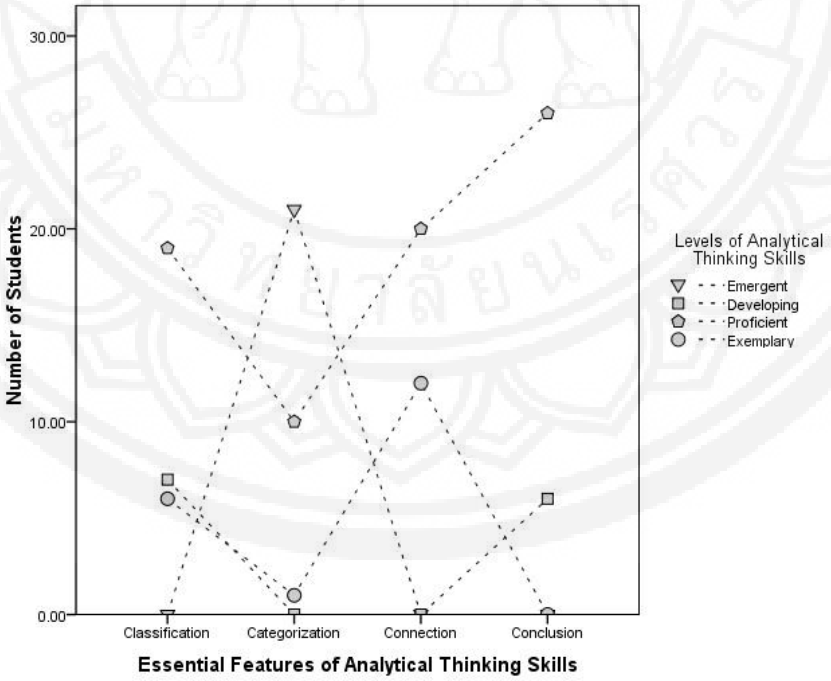

Figure 9 The number of students at each skill level for each essential feature of analytical thinking skills from subjective test 1

From performing subjective test 1, figure 9 shows the number of students that reached each skill level for each essential feature of analytical thinking skills. It can be seen that learning activities with integrating mind map raised the skill level in classification of many students to between developing and proficient, raised the skill level in categorization of many students to between emergent and proficient, raised the skill level in connection of many students to between proficient and exemplary, and raised the skill level in conclusion of many students to between developing and proficient.

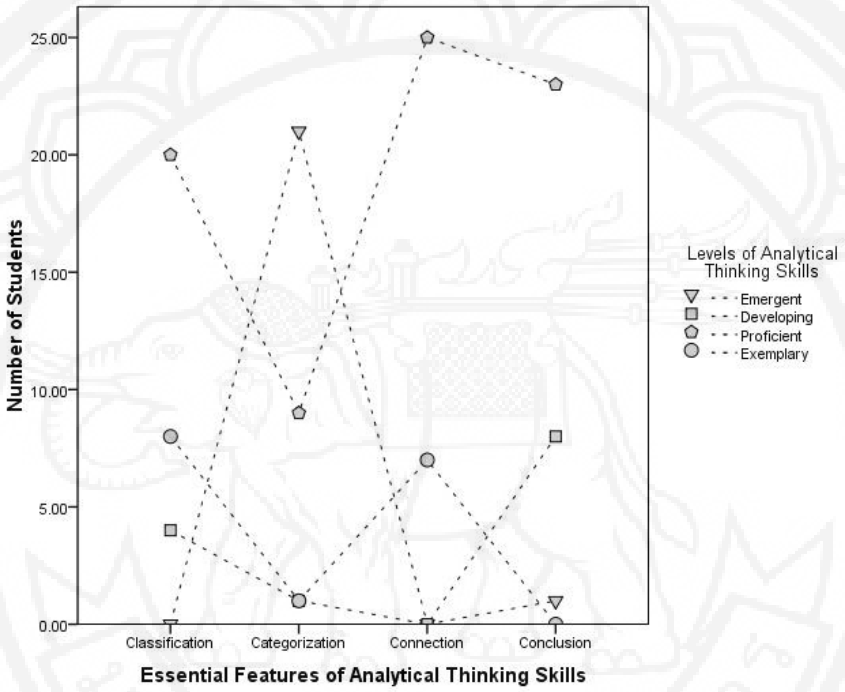

Figure 10 The number of students at each skill level for each essential feature of analytical thinking skills from subjective test 2

From performing subjective test 2, figure 10 shows the number of students that reached each skill level for each essential feature of analytical thinking skills. It can be seen that learning activities with integrating mind map raised the skill level in classification of many students to between proficient and exemplary, raised the skill level in categorization of many students to between emergent and developing, raised the skill level in connection of many students to between proficient and exemplary, and raised the skill level in conclusion of many students to between developing and proficient.

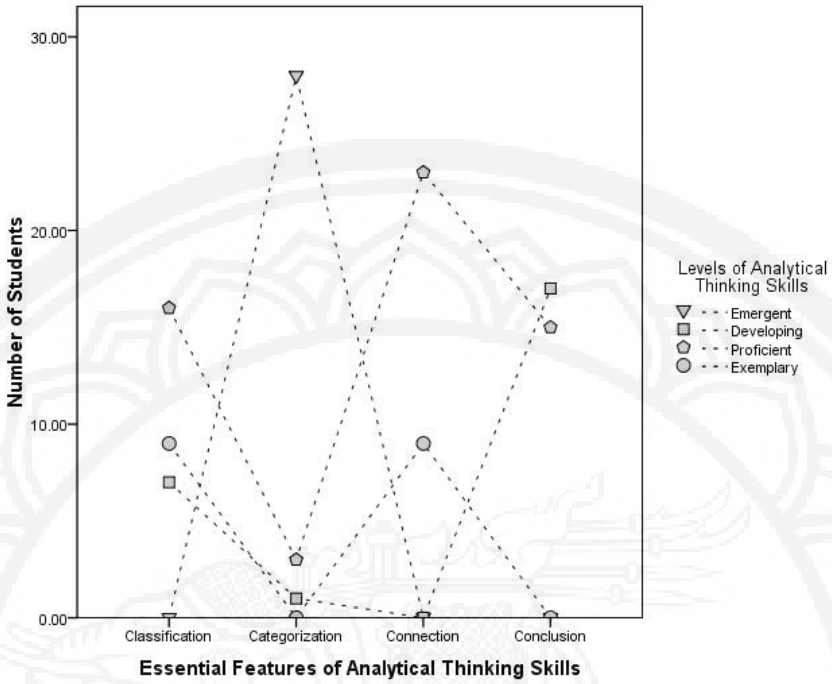

Figure 11 The number of students at each skill level for each essential feature of analytical thinking skills from subjective test 3

From performing subjective test 3, figure 11 shows the number of students that reached each skill level for each essential feature of analytical thinking skills. It can be seen that learning activities with integrating mind map raised the skill level in classification of many students to between proficient and exemplary, raised the skill level in categorization of many students to between emergent and proficient, raised the skill level in connection of many students to between proficient and exemplary, and raised the skill level in conclusion of many students to between developing and proficient.

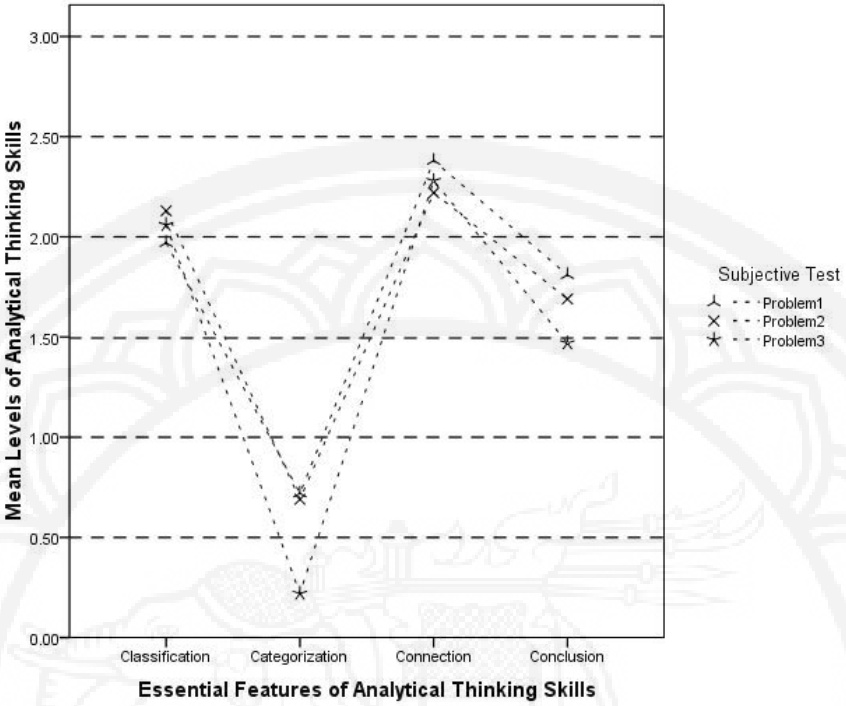

Figure 12 The mean score for skill levels of students for each essential feature of analytical thinking skills from performing in three subjective tests.

From performing all subjective tests, figure 12 present the mean skill level of students for each essential feature of analytical thinking skills to indicate the tendency of students' analytical thinking skill levels used in the process of problem solving. It can be seen obviously that learning activities with integrating mind map have an effect on analytical thinking skills in classification of students in proficient, analytical thinking skills in categorization of students in developing, analytical thinking skills in connection of students in proficient, and analytical thinking skills in conclusion of students in proficient.

Summary

Concerning our study goals, the attempt to explore the supportive use of learning activities with integrating mind map on the student's skill level in analytical thinking skills simultaneously happened in their problem solving process, we had verified the significant effect that learning activities with integrating mind map had an effect on students' analytical thinking skills. Students could acquire all topics on Variation through problem solving process. Students supported their analytical thinking to each other when encountered with problems by resolving process. In working groups with constructing mind map, their thinking were reflected on mind map in concrete form during they collaborated to identify problems, helped each other search information for solution, and made a discussion to reach conclusion. Thus, learning activities with integrating mind map not only encouraged students to learn content knowledge on Variation but also supported them to practice analytical thinking skills though constructing mind map in problem solving.

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