ORGANIZATION PROCESS OF PROBLEM-BASED LEARNING ACTIVITIES IN TEACHING MATHEMATICS IN HIGH SCHOOL

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Abstract: Vietnam's general educational program in 2018 is established according to the orientation of capacity development, regulations on basic and practical knowledge and proposals on methods for promoting activeness in the activities of learners, which helps form and develop the qualifications and ability of the students in line with requirements of social development. In the context of changing educational programs, teachers and students need to innovate teaching and learning methods towards development of capacity and fostering scientific thinking, capacity of exploration and knowledge self-acquisition, etc. The article presents the problem-based learning method and proposes the organization process of the problem-based learning process in teaching mathematics in high school.

Keywords: Learning activities; problem-based learning; teaching Mathematics, students, teachers.

1. INTRODUCTION

Innovation in teaching mathematics in high school must be synchronously implemented in all stages, including the contents of the program, teaching methods, forms of teaching organization, testing and evaluation. The general educational program and mathematics program in particular will change from 2018, designed in the direction of learner capacity development. Therefore, it is very necessary for high-school teachers and students to innovate teaching methods and forms in order to be in consistence and satisfaction with the goals and structure of the new general educational program.

The problem-based learning (PBL) is a form of learning that provides opportunities for students to study in groups, develop the skills of presentation, study on negotiation, research skills, self-study and knowledge acquisition (Savin-baden, 2000). The organization of PBL activities in teaching mathematics in high school will help students improve their ability in application of knowledge into practice by solving Mathematics-related problems related to Mathematics given by teachers. With the PBL method, teachers keep the role of trainers, instructors while students keep the role of the subject, actively studying to solve the problems in situations associated with the real world and related to course content. Therefore, the application of this learning form in teaching mathematics in high school is necessary and contributes to the goal of renovation of the new general educational program.

2. LITERATURE REVIEW

2.1. Problem-based learning in high school teaching

PBL is a learning activity in which students solve a problem through handling a life problem related to knowledge to be learned. The organization of activities under the PBL helps students focus on a complicated problem without prior answers, which leads the students to work in groups, cooperate to identify problems to be solved and then find out answers for the problem. The goals of the PBL is to help students have adequate subject knowledge, effective problem solving skills, team collaboration skills; self-study skills and self-improvement (Fearnside, 2004). The problem in the PBL often includes a description of a real situation. Students will work in groups to analyze, make problem format and solve problem on the basis of existing knowledge. The results are assessed through the activities and presentation of students in the group. PBL is established on three main principles: + Achieving the knowledge and deep understanding for future careers; + Self-reliance and initiative in learning; + Developing the skills of problem analysis and solving.

According to Henk Schmidt (1983), PBL is a learning form organized by teachers, accordingly, the students solve problem in small groups under the supervision and guidance of teachers. The problem in the PBL is often a problem associated with real situation in life. Students need to work in groups to analyze, format problems and solve problem on the basis of existing knowledge. Results are assessed through the process of performance and presentation of students in the group. According to Barbara J. Duch et al. (2001), PBL is also a way to instruct students the skills of learning and cooperating with members of the same group to find out problem-solving methods to complete the actual tasks

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from teachers. In addition, this learning method gives students the serious thinking ability, in-depth analytical skills, as well as skills for searching the supportive materials in the learning process. The important factor for the success of this method is the selection of unstructured issues (often interdisciplinary issues) and organization of earning experience for students under the guidance of teachers (Savery, 2006).

As such, it can be seen that the PBL-based teaching is a learner-centered form. PBL is a learning form with which students work in small groups to explore and gain knowledge in problem solving process to fulfill the tasks assigned by teachers to improve their ability in order to self-acquire knowledge and develop their thinking, abilities in co-operation, self-learning and communication of the students.

2.2. Characteristics of the PBL in teaching at high schools

According to Boud, D., Feletti, G (1998), the PBL has the following characteristics:

- *The problem is the central context of the activity under PBL:* The PBL-based learning cycle starts with the activity approaching the research problem of students at the beginning of the lesson, followed by the process of knowledge exploration of students in the process of finding answers to the problem through exploration and application of knowledge to solve the problem. Accordingly, in order to be able to organize teaching under the PBL, the "problem" is the key and plays a central role of learning activity because the "problem" will attract students to participate in the lesson, motivate excitement and curiosity of students so that students strive to find answers. Therefore, the "problem" will start up learning activities and also motivate students throughout the problem solving process.

- *Students will self-seek to achieve knowledge during the learning process under the PBL:* Based on the problems associated with the actual context of life, students are required to explore and study the sources of materials, the support from teachers and teammates to perform research activities for knowledge discovery to solve the problem. The students will have the support of the surrounding persons and the system of documents at the library, the internet, friends, however, the students must self-study and self-decide on problem-solving solutions.

- *The PBL's core activity is group activity:* The difference of PBL-based teaching method against the other teaching methods is that the learning activities of students will be through group discussion and

cooperation, the students do not individually perform their tasks. On the contrary, they will always coordinate with group members. With the method of group discussion, students will analyze the problem, identify important issues to be solved, so as to determine the information to be supplemented for problem solving. On the basis of shortcomings, the individuals will have periods of self-exploration and research. However, the information explored and studied by the individual is not always correct and necessary, therefore, the research results need to be discussed in group. Through inquiries in the group, the individual research results will be selected and analyzed, thereby, the most common and best solution will be given for the whole group. Through group discussions, the students will have the opportunity to express themselves, receive useful contributions from other individuals in order to improve themselves.

- *The PBL-based teaching changes the role of teachers*: In the past, in teaching methods, teachers keep the leading role in the process of teaching, assigning and organizing learning activities, the PBL has completely changed the role of teachers. In the PBL-based teaching, teachers only raise problems, assign tasks and attract, monitor students to participate in problem solving. Students will self-acquire knowledge, report and then teachers will add inadequate knowledge for them.

- *The students' knowledge for problem solving in the PBL is the integrated inter-subject knowledge:* The problem raised for students to solve in the PBL process is often the problem in reality, taking place in the real context to be solved. Therefore, the problem is often related to many areas of life, therefore, many inter-subject knowledge will be integrated to be solved. When students participate in problem solving, they will often have to apply a lot of knowledge of the subjects to give reasonable solutions in the learning process.

- *The PBL-based activities of students help develop the ability of communication with the environment outside the classroom:* The performance and co-operation of students for problem solving is not only related to teachers and members of the same group but also related to other forces outside the school like other teachers in the school, parents and social relations. The problem to be solved is associated with reality, therefore, it must be related to other fields of life, which requests students to communicate with more people. This way helps students develop the ability of communication and usage of language in the learning process.

3. METHODS AND RESULTS

3.1. Methods

This research mainly based on the documents analysis in order to provide some suggestions for teaching mathematics in high school based on PBL theory.

3.2. The organization process of problem based learning in teaching Mathematics at high school

Fearnside, Philip Martin (2004) states that PBL teaching cycle also includes 7 steps and the relationship between the steps is described by the following model:
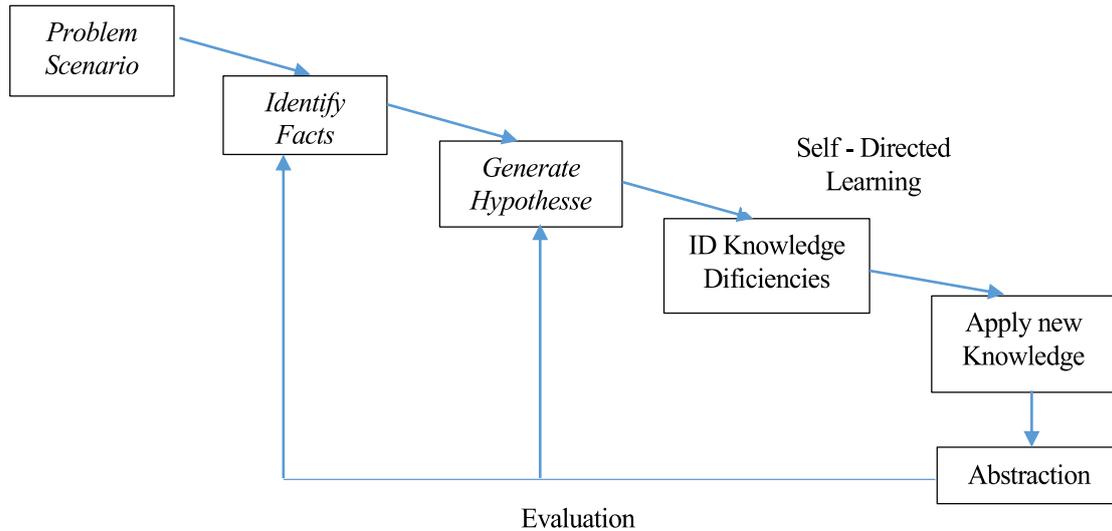
Step 4: Organize for students to make reports and evaluation on the working results of groups, adjust and supplement the knowledge that students have not absorbed.

Step 5: Clarify practical meaning, give similar situations, new situations.

In each step, there will be teachers 'activities and students' activities as clearly shown in the following model:

Figure 1. The problem-based learning cycle

According to James Busfield, Ton Peijs (2003), each teacher needs to organize the implementation by 7 steps as follows: - Step 1: Explain unknown wording, statements and concepts; - Step 2: Define the problem(s); - Step 3: Brainstorm - analyze/try to explain the problem(s); - Step 4: Make a systematic inventory of explanations; - Step 5: Formulate self-study assignments; - Step 6: Perform self-study assignments; - Step 7: Report and evaluate on self-study. After each group meeting, the group formulates the next stage of the self-study assignments.

We propose the process of teaching - learning Mathematics at high school under the PBL including 5 steps as follows:

Step 1: Define the content of knowledge and lesson objectives.

Step 2: Identify research issues, main questions for students, introduce reference sources.

Step 3: Organize for students to study the problem: Divide students into groups; assign problems to groups; organize and guide students to perform their tasks, specify the time for task completion.

3.3. Example of problem-based learning organization in teaching Mathematics at high school

We conduct the PBL-based learning activities in teaching "Defining and calculating cross-section area" in the part "solid geometry" of Grade 11 for high school students as follows:

Step 1: The teacher determines knowledge content, lesson objectives. Before studying a PBL course, it is necessary to identify the exact and specific lesson objectives. Lesson objectives should be based on the objectives to be achieved and knowledge objectives. It includes objectives on knowledge, skill and attitude.

The lesson objectives "Determination and calculation of cross-section" include:

* Knowledge: Students should know and understand the knowledge on: Perpendicular relations in space; Identify the cross-section; calculate the area of cross-section; Area of polygons

* Skill: The student has to proficiently calculate the projection area of a polygon; Apply knowledge on polygon area into applied problems in actual context.
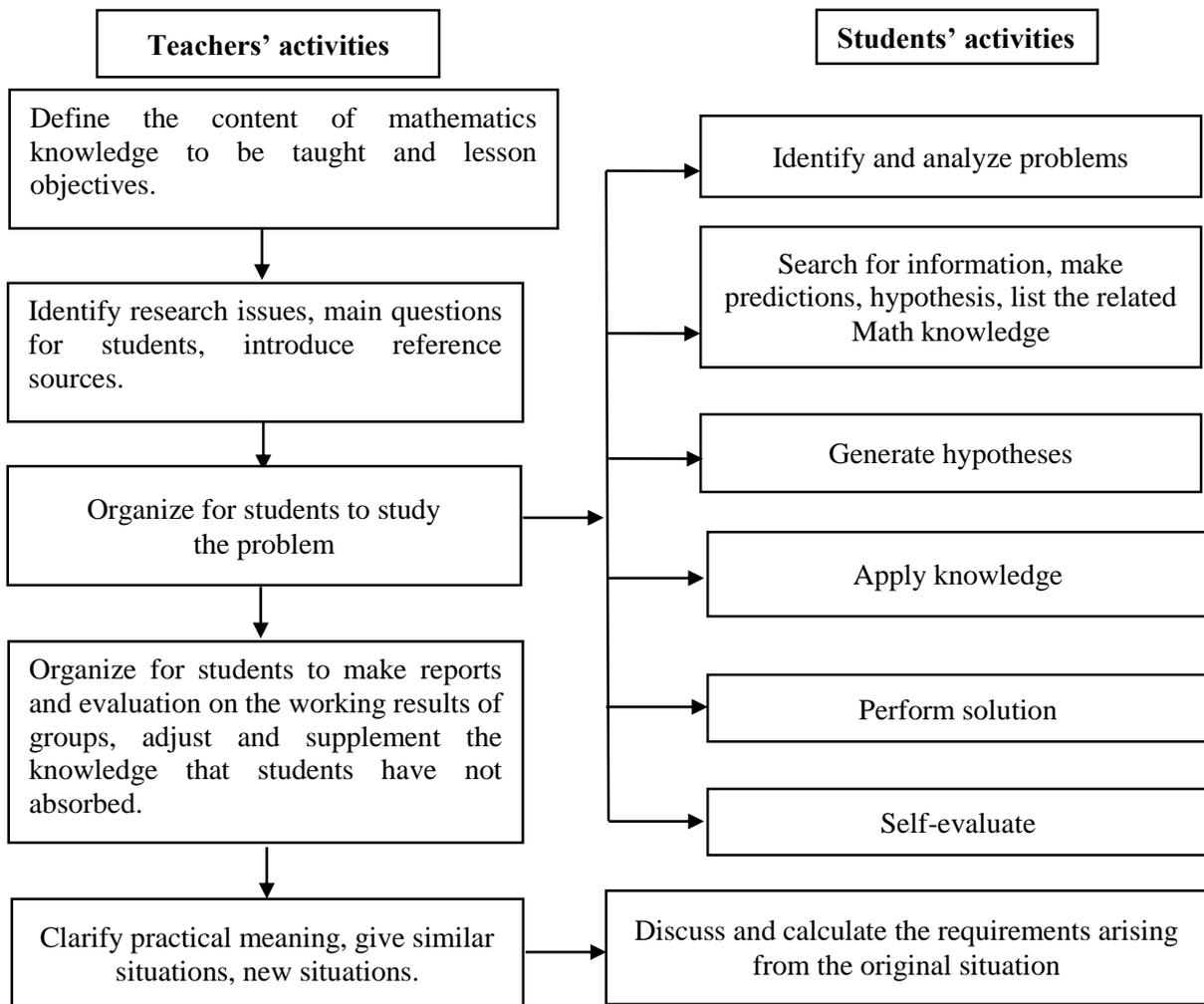
Figure 2. *Process of problem-based Mathematics teaching and learning*

* *Attitude:* The student must be active, positive, responsible for the assignments; The student should try to achieve the carefulness, accuracy and thinking skills of math problems in a logical and systematic manner while students have the co-operation ability; self-study ability; calculation ability, thinking ability; Ability of communication and assessment.

The content of "defining and calculating the cross-section area" knowledge is a part of knowledge significantly applied in the actual context such as: calculation of floor area; calculation of the area of land and houses, etc., therefore, it is necessary to select the problem associated with the actual context that is familiar in the daily life of students.

Step 2: Identify research issues, main questions for students, introduce reference sources

- Develop research problem: After having studied the issues associated with the actual context, in order to create the diversity, richness, synthesis from many fields for the problem, including: Mathematics, economics, fine art, etc., we develop research problems for students and questions for students as follows. Research problem: Hoa's family wants to build a house with an area of 100 m2, in which the house length is 20m; the house width is 5m; the front wall is 4m high; the back wall is 4.5m high. Hoa's parents desire to tile for the floor and make metal roof in the style of one-roof house for aesthetic quality, safety and health when living in the house. However, Hoa's parents are afraid of being too expensive to do so. Hoa loves their parents very much and wants to calculate how many bricks and tiles are needed for titling the floor and sizes of titles so that when they had to cut the tiles as little as possible and how many square meters of metal sheet to be purchased to save costs for her parents as much as possible. Hoa wondered and told the story to ask for the support from classmates. Using solid geometry

knowledge of grade 11, please calculate and solve the above problem.

- System of semi-structured questionnaires

+ Question 1: How is Hoa's your house model? Which tools will be used to draw Hoa's house model? + Question 2: How much is your home area and the area of metal roof? + Question 3: What tile sizes are there in the market today? What are prices of all kinds of floor tiles? + Question 4: What types of roofing sheets are there now? What are the prices of these types of corrugated iron? + Question 5: What are the solutions to minimize the cost for the Hoa's family when paving and making metal roof? Which plan should be advised to Hoa to bring the most economical benefits, durability and aesthetic quality?

Step 3: Organize for students to study the problem

- Dissemination of requirements, working ways, group division: + The duration of task performance is 1 week, in which the groups of students will have 2 classes to discuss and exchange with the teachers on the difficulties in the working process. + The teacher divides the class into 4 groups, including 8-10 students/ each group. Asking the groups to elect the leader, secretary and making the group working plan and inform all members and teachers on the group's general schedule.

- Plan on instructing students to solve problems: The students solve the problem based on the schedule 7 of the activities proposed in Figure 2, specifically.

+ *Activity 1: Identify and analyze problem:* Each individual is responsible for understanding the knowledge: polygon area, formula for calculation of polygon area; method of calculation of the area of other figures such as rectangles, squares, parallelograms; Perpendicular relations in space; Identify the cross-section;

+ *Activity 2: Search for information, make predictions of hypotheses, list the related math knowledge:* The groups will search for knowledge from the textbooks, reference books and related materials. Groups will search through the internet or conduct surveys at shops, companies of corrugated iron, tiles in terms of size, cost of materials, and make a detailed and specific list of such materials.

+ *Activity 3: Make hypotheses:* Based on the collected information, the team members discuss and give hypotheses for calculation for each type of tiles (the size of metal sheet should be chosen; gloss enamel or dim enamel, etc.) and the different metal roof (galvanized or galvanized alloy metal sheet should be used? Which wave for metal sheet should be chosen?). During group discussions, students can make hypotheses that are evaluated to be appropriate by the whole group. For example:

Plan 1: Choose the gloss enamel tiles, 50x50 size; Choose galvanized alloy metal sheet (to increase heat resistance for the house)

Plan 2: Choose the gloss enamel tiles, 60x60 size (priority in aesthetic aspect); Choose zinc (because of low cost)

+ *Activity 4: Applying theory:* The members of the group discuss and apply the knowledge that they had read about polygon area to calculate the area of corrugated iron roof, the floor area to be tiled. For each plan of tiling at different sizes, it is necessary to calculate the following points: How many bricks, how much they cost, how durable they are and how beautiful they are (with illustration models); In each plan with different types of metal sheet, it is necessary to calculate: Cost, safety and durability, aesthetics for the house (with illustration model).

+ *Activity 5: Implementation of the solution:* Each member will present their research results, answer their research questions, give design options and give Hoa advice. The whole group will discuss and propose the optimal plan, prepare the presentation before the class.

+ *Activity 6: Self-assessment:* Group members evaluate each other on work performance, cooperation results in the process of work, make comments and draw experiences.

Step 4: Organize for students to report on the working results of the groups, adjust and supplement knowledge that students have not absorbed

Organize for the groups to report, make comments and assess the performance of groups; discuss and present definitions, formulas for area calculation and application of such knowledge into real life.

Step 5: Clarify practical meaning, give similar situations, new situations

Organize for the groups to analyze, clarify the practical meaning, calculate the arising requirements (For example, it is unnecessary to floor the entire area of 100m² because there is a need to subtract the area for separating the rooms. Therefore, it is necessary to give a more detailed description on the diagram of rooms to calculate the quantity of bricks in the most reasonable way; add the requirements of aesthetics, specifically: in the living-room, the bricks with bigger size should be chosen while the bricks with smaller size should be chosen in the bathroom, etc.). Ask students to propose a

similar situation to apply, propose a new situation to develop ideas (requires titling for staircase, wall, etc.).

4. DISCUSSION AND CONCLUSION

The PBL is a student-centered positive teaching method that helps to comprehensively develop students' ability, especially cooperative ability, thinking ability, exploration, self-learning ability and communication ability in order to adapt to social development. In this article, we also focus on exploiting the organization of PBL activities in a way associated with the actual context of life. The organization of such teaching activity aims to develop mathematical competencies for students, and help students gain integrated inter-subject knowledge, improve their ability in applying Mathematics knowledge into life reality, accordingly, the student will clearly see the meaning of mathematics, and their interest and passion in learning will be fostered in order to improve the results of teaching Mathematics at high schools.

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