Developing students’ mathematical literacy through DAPIC problem solving process

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Abstract. Students’ ability to formulate, use and interpret mathematics in various contexts is called mathematical literacy ability. Hence, the purpose of mathematics learning is not only to make students able to use and apply mathematical knowledge in solving real-world problems or situations, but also to develop students’ mathematical literacy. The process of problem solving is carried out through five stages, namely defining, evaluating, planning, implementing and communicating. These five stages are known as the DAPIC problem solving process. The development of students’ mathematical literacy can be done through the DAPIC problem solving process. In this current experimental research, learning activities were developed by using lesson study analysis and synthesis and the DAPIC problem solving process. 64 of eighth grade students from junior high school were taken as subjects of study. There were five steps done by researcher in developing learning activities, namely (1) posing problems in real life contexts, (2) solving problems either individual or in group, (3) presenting and discussing student’s works, (4) developing formal mathematics, and (5) applying mathematical knowledge. The experimental group was given treatments of learning activities based on learning plans developed by researcher, while the control group was given learning activities based on traditional learning plans. Data on students’ mathematical literacy ability were obtained through mathematical literacy tests. Based on the results of the study, it can be evidenced that the mathematical literacy ability of students in the experimental class were higher than the mathematical literacy ability of those were in control class.

1. Introduction
Living in the time of the 21st century or the era of globalization, makes humans require the ability to find new concepts, open networks and sufficient competencies to meet high standards of the world of work. At present, every person is progressively more faced with various problems involving quantitative reasoning, spatial abilities, opportunities, or relational [1]. Existing information often uses Tables, graphs, diagrams, and other visual representations to explain various problems such as economics, weather, sports, and environmental conditions. Therefore, it is called for the ability to determine what knowledge is relevant, what processes must be passed to get a solution and how to depict the truth of the solution. Mathematical reading ability is acknowledged as mathematical literacy. Mathematical literacy can lead by the hand a person to observe and understand the use of mathematics in everyday life. So that mathematical literacy is an important thing in learning mathematics. Mathematical literacy is a basic ability in literation [2,3]. The importance of mathematical literacy is also a notice of the Indonesian governments, this is visible from the 2013 revised curriculum 2017 where learning activities must include 4 things, one of which is literacy.
Research link to each other to mathematical literacy include [4] which shows the differences in students' mathematical literacy abilities caused by the learning model applied by the teacher. In addition, students' mathematical literacy skills increased after being given learning using realistic mathematics education and DAPIC problem solving process [5].

According to NCTM [6], there are five fundamental abilities in mathematics learning, namely mathematical problem solving ability, mathematical reasoning ability, mathematical connection ability, mathematical communication ability and mathematical representation ability. These five essential abilities are actually competencies in mathematical literacy [7]. In addition, some experts describe mathematical literacy in a different way, including the ability to know and apply basic mathematics in daily life [8]. Mathematical literacy has four fundamental components (exploring, connecting, reasoning, and using various methods) to solve a problem [9]. Mathematical literacy comprises mathematical reasoning and the exertion of concepts, procedures, facts and tools to describe, explain and predict the existing phenomena [10].

Mathematical literacy has an exceptionally important role in someone’s life. Therefore, learning mathematics in schools should be designed so that it can extend students' mathematical literacy skills. Besides, learning mathematics in class aims to improve the aptitude of each student to use and apply mathematical knowledge to solve problems in the real world. The teacher plays an important role in providing learning experiences so that students can apply mathematics in their existence.

Mathematical literacy is not the product of teaching material content yet is the result of the instructional method applied by the teacher [9]. Traditional learning methods such as memorizing formulas cannot be directly related to conditions in routine life. This causes traditional learning methods do not correct students' mathematical literacy skills. Therefore, to improve mathematical literacy skills appropriate methods or learning processes are necessary to do. One of the learning processes that can be employed is the process of solving problems called DAPIC (define-asses-plan-implement-communicate). The process of resolving the DAPIC problem is based on the steps of the mathematical model of Polya [5].

This research was conducted to assign students' mathematical literacy abilities in the learning process using DAPIC problem solving process.

2. Methods
This research was established in 2 stages: developing learning process instruments and performing learning activities in the classroom (experiment). The development of the learning process is implemented using the DAPIC Problem-Solving Process. Researcher design a problem that takes place in everyday life to review the initial knowledge that is already possessed by students and is needed to acquire new knowledge.

The DAPIC problem-solving interaction showed in Figure 1. Based on figure 1, there are five key elements of the DAPIC process, specifically:

a. Define: aims to determine or define problems obviously;

b. Assess: aims to assess or understand the problem situation;

c. Plan: aims to plan how to solve problems

d. Implement: aims to carry out the plans that have been picked and to develop other plans that are more appropriate

e. Communicate: aims to analyse and evaluate the results of the application, and also to communicate the results obtained with others.

The population in this research was eighth grade students of SMP Negeri 11 Bengkulu city in 2017/2018 academic year with the number of the classes were 8 classes. Further, two classes were taken randomly as sample. Based on the lottery, it was obtained that class VIII D was as the experimental class while class VIII A was as the control class. In experimental class, its learning activities implemented DAPIC Problem Solving Process, while the control class implemented conventional processes.
Data collection was taken through using documentation method, mathematical literacy test, observation, and interview. Documentation was carried out to obtain data about students’ names, learning plans made by the teacher, and data on previous students’ learning outcomes. The observation method was utilized to achieve data about the quality of learning using DAPIC and conventional. The test was employed to acquire data about students' mathematical literacy abilities. Prior to the mathematical literacy test was given, a tryout was done to decide the validity, reliability, differentiation and level of difficulty of each item. Based on the tryout results, it was obtained that the mathematical literacy tests developed were proper to use in experimental activities.

The data were analysed through using gain test to notice the enhancement of each class and then using the t-test to know the difference in average increase between the two groups.

3. Results and Discussions
Analysis of differences in students' mathematical literacy skills was done by using t-test. The gain-test of mathematical literacy skills for each class was already seen beforehand. The results of the preliminary and posttests of mathematical literacy skills for the two classes are presented in the following Table 1.

| Class      | Preliminary-test | Post-test | (Pre-test) – (Post-test) |
|------------|------------------|-----------|-------------------------|
| Experimental | 35,7              | 81,6      | 45,9                    |
| Control     | 36,2              | 75,4      | 39,2                    |

From the former Table 1, it can be viewed that at the beginning the experimental class and the control class had nearly the same mathematical literacy skills. After learning activities, the differences in mathematical literacy skills are adequate visible. In addition, the gains obtained by the two groups also differed considerably. However, to gain accurate differences, t test is performed. The results of the t-test can be observed in Table 2 below.

| t count |  $\alpha$ | t tabel | conclusion | The meaning                          |
|---------|----------|---------|------------|--------------------------------------|
| 18,6    | 5%       | 1,67    | t count > t tabel | Reject Ho so that there are differences in students' mathematical literacy abilities |

Based on Table 2, it can be concluded that there are differences in mathematical literacy skills between students who get learning with the DAPIC Problem Solving Process and those who get conventional learning.

The results obtained in this study are in accordance with [11] which states that experimental class’s mathematical literacy was significantly higher after being given learning that combined realistic
mathematics education with DAPIC problem-solving process. DAPIC problem-solving process could provide better learning outcomes in mathematical literacy abilities due to several things, including:

a. Learning with DAPIC problem solving process began with teacher provision or presentation on a problem that occurs in everyday life to bridge the knowledge possessed by students to learn new knowledge. Giving problems related to everyday life could make students explore, connect, or use various methods in mathematics to solve them.

b. Learning with DAPIC problem solving process provided opportunities for students to analyse and try to understand the problems given and then determine or define the problem more clearly. Students participated in rediscovering and building mathematical concepts through learning activities in solving problems to improve understanding of procedures and concepts in mathematics.

c. At the problem solving planning stage, students could work either individually or in groups. This step was focused on collecting data related to the problem and assessing the problem situation to plan how to solve it. Students could find and create a model or method of their own development to solve problems by applying experience or methods that have been done. For example by drawing, creating Tables or making connections between ideas in the problem. In this activity students could assess problem situations, so that they could make models or methods of settlement that are easy and meaningful. This stage allowed students to use and choose most efficient model or method in solving problems.

d. The final step in the DAPIC problem solving process was to communicate. The teacher provided opportunities for students to present and discuss results of the method application they have chosen to solve problems. The discussion was an opportunity for students to exchange opinions to see the truth, adequacy and efficiency of various methods chosen, as well as to interpret the existing problem situation.

e. Student participation in class discussions that compare their completion with their classmates was a tool to develop students' abilities to express their ideas, argue, and assess their own solutions.

f. After students carried out class discussion activities, the teacher provided several problems existing in everyday life (which can be solved by the same method) for students to complete. In this activity students could do discussion with friends or teachers to verify and develop procedural and conceptual knowledge.

g. The teacher provided various forms of problems in real life so that students could apply them as a form of developing procedural and conceptual knowledge. Students tested the substance of the problem and chose carefully the procedures or concepts that match on each given problem. Furthermore, students were expected to develop procedural and conceptual knowledge to solve various problems in real life.

Based on the results of research on learning activities that use DAPIC, problem-solving processes resulted in students' mathematical literacy skills that are better compared to conventional learning processes. There are several things that must be considered in implementing DAPIC problem solving process, namely: (a) the use of problems in the real world that are already known by students as an initial step of learning can improve students' understanding on problems and make learning more meaningful; (b) asking students to participate in rediscovering and building mathematical concepts through learning activities and problem solving can improve understanding of better mathematical concepts and procedures; (c) giving students opportunities to assess problem situations and build models or methods of solving problems that are easy and meaningful can improve the selection and use of the most efficient model or method to solve problems; (d) the use of communication and interaction activities in classroom can help students to verify and develop mathematical ideas; (e) giving students opportunities to apply and solve various problem situations in various ways through testing the substance of the problem can improve their problem solving abilities.

In developing learning activities in class teachers can use the five steps above so that it can improve students' mathematical literacy skills, especially for junior high school students. Teachers can begin learning activities by analysing students' backgrounds and selecting problems related to the
student's background. This is aimed to make students can get better understanding on problems and can find appropriate solutions. In real field practice, a teacher must be patient and allow students to develop their own completion procedures and the teacher can help by being a facilitator using the heuristic method if needed.

4. Conclusion

Based on the results and discussion above it can be concluded that the literacy ability of students who get learning activities with the DAPIC Problem Solving Process is different from students who get conventional learning activities. Students' mathematical literacy skills will increase if in learning activities students are faced with real-world problems that are already known. Students can choose the most appropriate completion method by communicating their ideas to others. Therefore, teachers can use the DAPIC Problem Solving Process to improve students' mathematical literacy skills.

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