The implementation of problem based learning (PBL) model viewed from mathematical connection competence on x year students of vocational high school

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Abstract. The study aimed to prove the implementation of Problem Based Learning (PBL) model having better achievement than conventional model in improving students’ mathematic connection competence. The method used is qualitative with control group doing pretest and posttest. Population of the study were X year students of vocational school in Kabupaten Sukoharjo. The sample was X year students of SMK Pelayaran Pancasila Kartasura. Instrument used was test of mathematical connection ability. The result showed that with significance level $\alpha = 0.05$ showed that Problem Based Learning (PBL) model was better significantly than conventional learning model to improve students’ mathematic connection ability.

1. Introduction
Mathematics is a basic science, either in its applied aspect or in logical aspect, has important role in mastering science and technology. Mathematics can also be used as a principle in learning and socializing in a community. For example, those, who have learnt mathematic are expected to be able to logically absorb information and think to face situation in the community. Mathematic education at school is a medium to improve, develop, and learn students’ potentials. It, therefore, must be taught in all education level, from elementary school to higher education.

According to Permendiknas No 22 Tahun 2006 [1], one goal of mathematic in high school is that students have ability to understand mathematic concept, to explain the relation among concept, and to apply concept or algorithm easily, accurately, efficiently, and correctly in solving problem.

As the importance of mathematic, its learning must be improved and repaired. However, the implementation process and result found several limitation. Teachers, therefore, are required to have more competence to master and apply learning methods and models. In fact, it was not easy to perform, due to teachers generally still dominate classes, so learners were passive. Moreover, learners regard that mathematic is difficult and complicated to learn. This argument is supported by [2] stating that “Fact in field shows that mathematics is less-liked subject and even it is frightened learners, due to it is regarded as difficult, complicated and tricking knowledge.”

A learning process must involve learners to be active in order to achieve learning objectives. Based on the result of observation and interview to several mathematic teachers in SMK Pelayaran, it showed that daily mathematic test result of X year students lies in the last level of 64 subjects. The score was far from the passing grade determined that was 75. It was strange that the learners’ score would be decreased...
when they were preciously informed that there would be test. In addition, the score would be raised if they were informed of test.

| Subject                  | Score | Passing Grade | Description |
|--------------------------|-------|---------------|-------------|
| Religion and Ethic       | 87    | 75            | Achieved    |
| Civic                    | 85    | 75            | Achieved    |
| Bahasa Indonesia         | 85    | 75            | Achieved    |
| Load Management          | 83    | 75            | Achieved    |
| Maritime English         | 80    | 75            | Achieved    |
| Visual Gesture           | 80    | 75            | Achieved    |
| Physical Education       | 80    | 75            | Achieved    |
| Craft and entrepreneurship| 78    | 75            | Achieved    |
| History of Indonesia     | 78    | 75            | Achieved    |
| Javanese                 | 78    | 75            | Achieved    |
| Cultural Art             | 76    | 75            | Achieved    |
| English                  | 72    | 75            | Not Achieved|
| Mathematic               | 64    | 75            | Not achieved|

Source: Curriculum of SMK Pelayaran

To support data and information of several mathematic teachers, the writer interviewed several learners of XI year randomly. Result of the interview showed that 4 of 6 learners interviewed admitted that there was afraid if they were informed such a test previously and they forgot material they had learnt. It was caused that learners did not understand the material well indicated by the class average score was low and did not achieve the passing grade.

| Class                  | Score | Passing Grade | Description |
|------------------------|-------|---------------|-------------|
| X Nautika A            | 62    | 75            | Not achieved|
| X Nautika B            | 63    | 75            | Not achieved|
| X Teknika A            | 65    | 75            | Not achieved|
| X Teknika B            | 65    | 75            | Not achieved|
| X Teknika C            | 65    | 75            | Not achieved|

Source: Mathematic Teacher of SMK Pelayaran

The initial mathematic competence score showed the spread of learners in each class as follow:

| Class                  | Category KAM |
|------------------------|--------------|
|                        | Low | Medium | High |
| X Nautika A            | 6   | 22     | 7    |
| X Nautika B            | 5   | 24     | 5    |
| X Teknika A            | 4   | 26     | 5    |
| X Teknika B            | 7   | 18     | 6    |
| X Teknika C            | 5   | 23     | 5    |

Source: Mathematic teacher of SMK Pelayaran

Learners’ low competence in solving mathematic problem relating to connection competence was a problem in mathematic learning. Mathematic is a subject, which the themes are integrated. The better
mathematic connection competence the learners have, they are able to look at wider interaction among mathematic themes reflecting the more meaningful mathematic learning. The most useful competence is when they are able to connect concepts relating to the most suitable ways [3]. The X year students have been able to observe interrelated concept, principles or procedure well, and give argument to explain it, so they are able to give deep understanding and to improve their self-confidence. An alternatives in learning beside mathematic connection is Problem Based Learning (PBL) learning model. It uses constructivist approach, where learning focuses on learners to make them act actively in learning. Effort to improve mathematic thinking competence and skill, particularly the connection, need to get more attention from teachers, the facilitator of learning process. There are many ways to develop learners’ reasoning competence, such as teacher motivates learners to think logically by giving application question in daily life changed to mathematic form. Learners can also develop their reasoning competence by trying to analyse something using steps in theory and mathematic concept. Through mathematic learning, learners are expected to have logical, analytic, systematic, critical, and creative thinking skill, and cooperative [1]. It means that problem solving skill is something requiring special attention due to the strategic role in developing learners’ intellectual potentials. The skill relates to learners’ mathematic understanding. [4] states that “The first step in solving mathematic problem is understanding the mathematic problem itself.” The correlation between understanding and problem solving is that when someone has understood mathematic concepts, he or she is able to apply them to solve problem.

It is relevant to research conducted by [5] that “problem based learning resulted higher long term content retention than the conventional one”, their study using “Problem Based Learning approach improved learners’ reasoning skill and competence than the conventional one.” The study conducted by that “problem based learning improved learners’ motivation and attitude toward learning than the conventional one.” Learners’ having positive attitude seemed to learn actively than those with negative attitude. Susilo et al. (2012) states that PBL model is possibly applied when teacher is able to create open class environment and guide the ideas exchange. Teacher has role to stimulate, guide learners activity, and determiner of learning as a pattern of conceptual framework containing systematic procedure in organizing learning activities to achieve learning objective [6] The education psychologist and mathematic researchers have been thought that the existence and then studied the influence of learners’ belief, attitude, emotion, value, and internal motivation on mathematic problem solving. It was believed that the four component related rigidly on cognition, so it supported as well as inhibited problem solving process. The similar result found by [7] in senior high school learner’s taught using inquiry model Alberta. Using the approach, Gani succeeded to improve significantly learners’ positive attitude toward mathematic. Mathematical connection ability is knowing, using, and making interrelation among mathematic ideas in context of outside mathematic to build mathematic understanding (NCATE/ NCTM) [8] Otherwise, in conventional class, learners’ attitude on mathematic was doubtful or neutral or did not know. The research finding above was inconsistent. However, in learning mathematic, teachers facilitate learners to involve in understanding mathematic objects and build positive attitude either toward mathematic or its problem solving. The positive attitude in learning gives motivation benefits. It needs to attend that, [9]. Then Mathematic is a knowledge having characteristics of structured, hierarchy, and systematic meaning that a concept and principle covered in mathematic is interrelated [10]. also reminded the importance of building learners’ positive attitude on mathematic. Therefore, it must be remembered that the biggest chance for teachers to do so is in learning process in the classroom to solve problems and to answer questions explained.

Learning process in mathematic connection is a learning process of mathematic thinking ability defined as the relationship among internal mathematic concepts. Steps in Problem Based Learning has particular characteristic in its learning steps. According to to Fathurrohman the steps of implementing Problem Based Learning is as follow: (i) Organizing learners on the problem; (ii) Organizing learners to study, consist of: Clarifying problem given, identifying problem, exchanging ideas based their knowledge or expressioniopn, determining things needed to solve the problem by discussion, and determining things should do to solve the problem; (iii) guiding either individual or group inquiry; (iv) developing and presenting result (v) analysing and evaluating problem solving process [11].
Thus, Problem Based Learning is a learning model using real life problem as a context for learners to study how to think critically, to have problem solving skill, to get knowledge and concept in learning material and learn how to interact and cooperate competences.

| Stage | Teacher Activity | Students activity |
|-------|------------------|-------------------|
| Stage 1 | Explaining learning goal, tool needed to propose phenomena or information (based on the basic competence learned) to create problem, motivating learners to be involved in problem solving process. | Listening to teacher’s explanation and preparing themselves to be in discussion group by teacher guidance. (Observing) |
| Stage 2 | Assisting students to define and organize learning assignment related to the problem. | Having group discussion of problem solving given by teacher. (asking) |
| Stage 3 | Stimulating and motivating students to gather suitable information, have group discussion to get explanation and problem solving. Giving assignment to look for data source by interview to the relevant informant and references. | Searching and collecting suitable information / source to solve the problem. Writing report of the group discussion result. (Collecting information) |
| Stage 4 | Assisting students in planning and preparing discussion result report and assisting them to divide job with their friends to compose and write report. | Presenting group discussion result in front of the class. (Associating) |
| Stage 5 | Assisting students to present the group discussion result, having reflection or evaluation toward their inquiry and the process they used. | Concluding material and doing posttest. (Communicating) |

2. Methods
The study used qualitative method to investigate the influence of learners’ mathematic connection competence on the implementation of problem based learning (PBL) model. The study was conducted in the first semester of 2017/2018 academic year in SMK Pelaya ran. The random sampling was used to find class on the study based on category of learners’ mathematic connection in class XNA, XNB, XNC. The test result showed that each category had high, medium, and low mathematic connection competence. The material observed was three variable linear equation. They previously were tested to determine their competence. Student 1 was noted as (S1), subject 2 (S2), and subject 3 (S3). Table 1 showed method used to determine learners’ mathematic connection competence level by applying Problem Based Learning (PBL) model model, indicator students mathematic connection [12] as follow The following is indicator of mathematic connection:
Table 5. Indicator of mathematic connection

| No | Indicator                                                                 |
|----|---------------------------------------------------------------------------|
| 1  | Determine the issues or problems in other fields related to the mathematical concept, |
| 2  | Recognize the relationships between concepts or idea in mathematics.       |
| 3  | Apply mathematics in contexts outside of Mathematics (the problems of everyday life |
| 4  | Determine the mathematical concepts underlying the issue or problem resolution procedures. |
| 5  | Understand how concepts in mathematics are related.                       |

3. Results and Discussion

Mathematic connection competence categories were taken from total scale of mathematic connection measurement. It indicated that essay test in the study measured learners’ mathematic connection competence level.

3.1. Subject with high mathematic connection competence level

Below is the answer of S1

![Figure 1. The Answer of S1 With high mathematic connection competence level](image)

The analysis of learners’ test answer indicated that subjects, who had high mathematic connection competence level taught by Problem Based Learning (PBL) and had good learning model and mathematic connection competence were those getting ability to connect mathematic topics in algebra using elimination and substitution method. The subjects having high mathematic connection competence were those who were able to connect one topic to another well.
3.2. Subjects with medium mathematic connection competence level

Below is the answer of S2

![Figure 2](image)

**Figure 2.** The Answer of S2 With medium mathematic connection competence level

Based on the analysis of test result, it indicated that subjects having medium mathematic connection competence taught by Problem Based Learning (PBL) used their competence well to connect three variable linear equation connected to algebra using elimination and substitution method although there was still error but generally they could connect one topic to another.

3.3. Subjects with low mathematic connection competence level

Below is the answer of S3

![Figure 3](image)

**Figure 3.** The Answer of S3 with low mathematic connection competence level

Based on the analysis of test result the data analysis of answering test showed that subjects with low mathematic connection competence taught by Problem Based Learning (PBL) could not connect algebra using elimination and substitution indicated by their wrong answer entirely.

4. Conclusion

Based on the mathematical connection test given to the object of the study, it can be concluded that learners with high mastery of three variable linear square equation also have high mathematic connection competence, otherwise, learners with low mastery of the same material have low competence. And to
solve problem outside mathematic connection requires precision. It influences the process of finding solution. If errors happen initially on the earlier step, it will influence the answer of the question.

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