The integration of local context through problem-based learning (PBL) to improve junior high school students problem-solving skills

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Abstract. Students face difficulties in understanding problems because they are presented in the textbook without the contexts familiar to the students. This study aimed to examine and descriptively describe the effectiveness of the integration of local contexts through the PBL model to improve students’ problem-solving skills. This research was done by developing the learning instruments integrating the local contexts through the PBL model based on Dick and Carey models. The learning instruments that are valid, practical, and effective were developed by referring to the Dick and Carey model. This paper discussed the results of the effectiveness test of PBL learning instruments integrating the local contexts. The effectiveness test was conducted for Year 7 students at one of the junior high schools in Meureudu, Pidie Jaya, Indonesia. The instruments of this study were the student worksheet, observation questionnaire to investigate student learning activities, problem-solving skills test, student questionnaire, observer questionnaire. The results showed that effectiveness criteria to the learning instruments developed had been fulfilled so that they were effective to use, and students problem-solving skills had improved. It is hoped that the trial of the learning instruments can be conducted at some schools with similar characteristics.

1. Introduction

The problem-solving skill remains a concern in mathematics teaching and learning. Fostering problem-solving skill as one of the educational objectives is required to obtain the applicable knowledge and train students to face various problems in their real-life [1]. Based on the preliminary research conducted, it was found that the students’ mathematical problem-solving skills at one of the junior high school in Meureudu, Pidie Jaya were lacking. This finding indicates that teachers need to put more efforts and hard work to prepare the mathematics problems in the form of problem-solving and continue to train students to solve the problems independently. Moreover, the 2013 curriculum also demands teachers to be more creative, innovative and effective in teaching, by exploring the students’ existing knowledge gained from their daily lives so that it can contribute to improving students’ mathematical problem-solving skills in the classroom [2].

When students learn to solve problems in mathematics, they identify the ways of thinking, the hard- working habits, the high curiosity, and the self-confidence in non-routine circumstances which they will experience outside the mathematics classroom [3]. Presenting problems related
to the local context is one of the means to explore student knowledge in students text books. The local context inclusion in mathematics learning will help students in understanding the problems. The cultural aspects are useful to introduce mathematics as a part of daily life, develop connection skill meaningfully, and deepen the mathematical understanding [4]. Therefore, the integration of the local context will enable students to learn more meaningfully, think critically, and be confident; the skills can then be applied beyond the mathematics classroom.

Local context is a condition in the students’ environment, which includes real object, scenery, and event. The presence of contexts in mathematics learning will help students to understand and solve problems. Contexts also play an important role as a starting point for students to explore mathematical concepts in real situations or events that happened in students’s life [5]. As for the main role of context in mathematics learning is (1) improve accessibility to problems, (2) contribute to the transparency and elasticity of the problem, and (3) suggest problem-solving strategies to students [6].

One of the learning models to improve problem-solving skill and incorporate the local contexts is Problem Based Learning (PBL) model. PBL presents contextual problems to stimulates students to learn [7]. PBL enables the meaningfulness in learning since it is the basis of investigation for students [8]. PBL helps students to develop their thinking, problem-solving, and intellectual skills, to learn various adult roles by their involvement in real or simulated experiences, and to become autonomous and independent learners [9]. PBL is one of the learning demanding students to think critically, solve problems, learn independently, and work in a group [10]. PBL is learning to employ ill-structured and open authentic problems [11]. Thus, the PBL learning instruments allow students to enhance their mathematical problem-solving skills as it involves students directly to conduct the stages of activities to solve a problem using their way. They consult various information or references without having to refer to and imitating their teacher in solving problems related to real-life, which in turn can increase their creativity and enrich their insight about what is known and what they need to know to solve problems. PBL syntax conducted to improve students’ problem-solving skills are: (1) orientating the students to the problem, (2) organizing students in learning, (3) guiding students in individual and group investigations, (4) developing and presenting the work, (5) analyzing and evaluating the problem solving process [12].

Students’ problem-solving skills can also be measured by (1) students’ understanding of how to solve problems including identifying the known data, identifying the data being asked, identifying the data required, and checking the data adequacy [13]; (2) planning the solution or selecting strategies [14]; and (3) applying strategies or calculations to solve various problems [15]. The four steps of problem-solving are (1) understanding the problem, (2) planning the solution, (3) solving the problem, and (4) re-checking [16]. Therefore, in solving problems, students need to understand the problem, solve the problem systematically, and re-check the work.

The research conducted by [17-19] showed that PBL learning instruments could improve students’ problem-solving skills. However, previous researchers have not integrated the local context in PBL models. The integration of the local context in the PBL model will stimulate students to learn, understand problems easily, develop critical thinking, work in groups to solve problems independently. Therefore, it is necessary to develop learning instruments that integrate local contexts in the PBL model. The research problem in this study is how is the effectiveness of learning instruments integrating the local context in the PBL model?.

2. Method
This research was design research describing the effectiveness of the learning instruments developed, referring to Dick and Carey. It consisted of nine stages including identifying the learning objectives, analyzing the learning, identifying the students’ characteristics and behaviour, formulating the learning objectives, developing test items, developing learning strategies, developing and selecting the materials, designing and conducting a formative evaluation and revising [20]. According to the stages of Dick and Carey, the learning instruments developed was valid, practical, and effective.
This article only discussed the results of the effectiveness test of PBL learning instruments that met five out of six indicators of the effectiveness, including: (1) the average of students’ on-task activities should be at least 90%, (2) The average of students’ activities should be at least 90%, (3) The suit ability level of the observed and expected student activities should be at least 80%, (4) There is an increasing trend of the formative test scores, (5) More than 50% of students provide a positive response on the learning instrument developed, (6) The teachers provide a positive response on the learning instruments developed [21]. The instruments of this study were student worksheet, observation questionnaire to investigate student learning activities, a problem-solving skills test, student questionnaire about the learning instrument developed observer questionnaire about the learning instrument developed.

3. Results and Discussion
Based on the effectiveness test of the learning instruments following the indicators of effectiveness proposed by Kemp, Morison & Ross [21], the results are as follow.

3.1 The analysis results of students’ on-task activities
Students’ on-task activities were determined based on the scores of student worksheet from meeting I to IV. The developed student worksheets consisted of Worksheet 1, 2, 3, and 4. The students worked on the worksheet in groups. Figure 1 presents one of student works on the worksheet.

![Figure 1. One of the students' works on the worksheet](image)

Students’ works were then analyzed using the assessment rubric. Table 1 is the analysis results of students’ score for the worksheet.

The analysis results of student worksheet scores presented in Table 1 show that the average scores for group I, IV, and V are excellent, while the score for group II, III, and VI are good. The overall score of the students is 90.28. The quality of student group collaboration kept increasing in each meeting. It was evidenced by the increasing group scores in solving problems presented in the worksheet integrating the local context through the PBL model from the first to the fourth lesson. Based on the overall mean score of the worksheet, students had been able to use and work on the worksheet developed very well. Thus, the analysis results of students’ on-task, as indicated by the group scores in each meeting were achieved. The increasing scores on the worksheet were because students could easily understand the problems. They can solve the problems using their way, referring to the knowledge they acquired from formal education and everyday life without copying the teacher works. This finding is in line with [4] stating that cultural aspects are beneficial to introduce mathematics as a part of everyday life, to develop connection skills meaningfully, and to deepen mathematical understanding of the students.
Table 1. Students’ worksheet score analysis

| No | Group | Score          | Mean | Criteria |
|----|-------|----------------|------|----------|
|    |       | Worksheet 1    | Worksheet 2 | Worksheet 3 | Worksheet 4 |       |          |
| 1  | I     | 87.50          | 91.67 | 95.83    | 95.83 | 94.79 | Excellent |
| 2  | II    | 83.33          | 87.50 | 87.50    | 91.67 | 87.50 | Good    |
| 3  | III   | 87.50          | 87.50 | 87.50    | 87.50 | 87.50 | Good    |
| 4  | IV    | 87.50          | 83.33 | 95.83    | 95.83 | 90.63 | Excellent |
| 5  | V     | 87.50          | 87.50 | 95.83    | 95.83 | 91.67 | Excellent |
| 6  | VI    | 87.50          | 87.50 | 91.67    | 91.67 | 89.58 | Good    |
|    | Total |               |       |          |       | 90.28 | Excellent |

3.2 The analysis results of students’ activities

The observation aimed to investigate student learning activities using learning instruments developed during the learning. The observation data were from two mathematics teachers. The data were analyzed using the descriptive analysis (percentage). Table 2 presents the analysis results of the observation data on students’ activities.

Table 2. The analysis results of the student’s activities observation

| No | Group | Lesson | 1 | 2 | 3 | 4 | O I | O II | Mean | O I | O II | Mean | O I | O II | Mean | Mean |
|----|-------|--------|---|---|---|---|-----|------|------|-----|------|------|-----|------|------|------|
| 1  | I     |        | 92%| 96%| 94%| 96%| 96% | 100%| 100%| 100%| 100%| 100%| 100%| 100%| 98% |
| 2  | II    |        | 88%| 92%| 90%| 92%| 92% | 92% | 92%  | 92% | 92%  | 92% | 96% | 96% | 96% | 96%  |
| 3  | III   |        | 92%| 88%| 90%| 92%| 88% | 90% | 92% | 92% | 92% | 92% | 92% | 92% | 92% | 93%  |
| 4  | IV    |        | 88%| 92%| 90%| 92%| 92% | 92% | 96% | 100% | 100% | 100% | 100% | 100% | 100% | 95%  |
| 5  | V     |        | 96%| 96%| 96%| 96%| 96% | 96% | 100% | 98% | 100% | 100% | 100% | 100% | 100% | 98%  |
| 6  | VI    |        | 92%| 88%| 90%| 92%| 92% | 92% | 92% | 92% | 92% | 92% | 92% | 92% | 94% | 98%  |
|    | Total |        | 92%| 93%| 96%| 96%| 96% | 96% | 96% | 96% | 96% | 96% | 96% | 96% | 96% | 98%  |

Oi is Observer I and OII is Observer II

The overall mean students’ activity indicates that the students’ activities during the learning steadily increased in each lesson, and the activities of each group are categorized as excellent. On average, students’ activities score in the group was more than 90% for each lesson. This means that student learning activities in the learning utilizing learning the instruments developed falls into the excellent category. The learning conducted with the PBL learning instrument integrating the local contexts stimulates students to learn. This finding agrees with Marzano [7] who believed that PBL learning presenting contextual problems, encourage students to learn.

3.3 The analysis results of student test scores on problem-solving skills

The improvement of students’ problem-solving skills can be identified by comparing the students’ problem-solving skills test scores before and after the learning using the learning instruments developed. Figure 2 displays one of the students answers in the problem-solving skills test.
Before students learn to use the developed learning instruments, their problem-solving skills test scores were low. No students satisfied the minimum criteria of mastery learning set by the school (≤70). However, 100% of students met the minimum criteria of mastery learning (≤70) after they experienced the learning using the learning instruments developed. Thus, students’ problem-solving skills increased because PBL is the learning utilizing authentic problems that are unstructured and open [9]. Therefore, the implementation of the learning employing the PBL learning instruments, integrating the local contexts and the problems being presented with incomplete or implied instructions, foster the students to think critically. It also accustoms students to have high curiosity, to seek information from multiple sources, to conduct experiments and to link to other subjects they learned before.

Table 3. The analysis results of students’ positive responses to the student book

| No | Score | Percentage | Criteria   |
|----|-------|------------|------------|
| 1  | 70    | 97.22      | Excellent  |
| 2  | 63    | 87.50      | Good       |
| 3  | 58    | 80.56      | Good       |
| 4  | 63    | 87.50      | Good       |
| 5  | 58    | 80.56      | Good       |
| 6  | 72    | 100.00     | Excellent  |
| 7  | 63    | 87.50      | Good       |
| 8  | 72    | 100.00     | Excellent  |
| 9  | 67    | 93.06      | Excellent  |
| 10 | 63    | 87.50      | Good       |
| 11 | 64    | 88.89      | Good       |
| 12 | 71    | 98.61      | Excellent  |
| 13 | 65    | 90.28      | Excellent  |
| 14 | 63    | 87.50      | Good       |
| 15 | 65    | 90.28      | Excellent  |
| 16 | 66    | 91.67      | Excellent  |
| 17 | 63    | 87.50      | Good       |
| 18 | 63    | 87.50      | Good       |
| 19 | 67    | 93.06      | Excellent  |
| 20 | 65    | 90.28      | Excellent  |
| 21 | 72    | 100.00     | Excellent  |
| 22 | 48    | 66.67      | Inadequate |
| 23 | 71    | 98.61      | Excellent  |
| 24 | 64    | 88.89      | Good       |
| 25 | 58    | 80.56      | Good       |
| 26 | 59    | 81.94      | Good       |
| 27 | 63    | 87.50      | Good       |
3.4 The analysis results of students’ positive responses to the learning instruments developed

Students positive responses were based on students’ assessment of the student book and worksheet conducted during the trial. Data of Student questionnaire were analyzed using percentage. Table 3 and 4 show the analysis results of student questionnaire data on student book and student worksheet.

The analysis results of students responses to the student book shown in Table 3 indicates that 26 students (96.30%) provided positive responses on student book, meaning that they rated the book positively.

| No | Score | Percentage | Criteria |
|----|-------|------------|----------|
| 1  | 47    | 90.38      | Excellent|
| 2  | 48    | 92.31      | Excellent|
| 3  | 48    | 92.31      | Excellent|
| 4  | 34    | 65.38      | Inadequate|
| 5  | 51    | 98.08      | Excellent|
| 6  | 44    | 84.62      | Good     |
| 7  | 51    | 98.08      | Excellent|
| 8  | 43    | 82.69      | Good     |
| 9  | 45    | 86.54      | Excellent|
| 10 | 52    | 100.00     | Excellent|
| 11 | 45    | 86.54      | Good     |
| 12 | 52    | 100.00     | Excellent|
| 13 | 45    | 86.54      | Good     |
| 14 | 47    | 90.38      | Excellent|
| 15 | 48    | 92.31      | Excellent|
| 16 | 47    | 90.38      | Excellent|
| 17 | 47    | 90.38      | Excellent|
| 18 | 44    | 84.62      | Good     |
| 19 | 47    | 90.38      | Excellent|
| 20 | 44    | 84.62      | Good     |
| 21 | 45    | 89.54      | Good     |
| 22 | 44    | 84.62      | Good     |
| 23 | 45    | 89.54      | Good     |
| 24 | 46    | 88.46      | Good     |
| 25 | 44    | 84.62      | Excellent|
| 26 | 52    | 100.00     | Excellent|
| 27 | 41    | 78.85      | Adequate |

Table 4 presents the analysis results of the student responses on the worksheet, 25 students (92.59%) provided positive responses. This indicates that more than 50% of students positively rate the student book. The results of the questionnaires administered to 27 students (one of Year 7 class) concerning the student book and the worksheet indicates that more than 50% of students have a positive response on the learning instruments developed.

3.5 The analysis results of teacher positive responses to the learning instrument developed

Data from the teacher questionnaire concerned on the teachers’ assessment of the teacher book, student book, lesson plan, and student worksheet from the teachers’ perspective. The data was obtained from two mathematics teachers and analyzed using descriptive analysis (percentage). The results of the teacher questionnaire data analysis showed that the assessment for teacher book, student book, lesson plan, and worksheet accounted for 87.08%, 85.63%, 83.68, and 82.50%, indicating that teacher’ assessment of the teacher book, student book, lesson plan, and student worksheet were categorized as good. This finding suggests teachers' positive evaluation of the learning instruments developed.
Prior to the learning using the instruments developed, the mean score of the students and the observer’s assessment of the average student activities were above 90%. In addition, the scores concerning students’ problem-solving skills test and students questionnaires related to the developed learning instruments increased; and the observer provided positive assessment for the learning instruments developed. The instruments developed satisfied five out of six indicators [21]. Thus, it can be concluded that they are effective to use. A learning instrument is effective if fulfills the objectives to be achieved [22]. In this study, the aim was to improve students’ problem-solving skills.

4. Conclusion
The PBL learning instruments developed satisfied the criteria of effectiveness as evidenced by 1) the score of students’ group assignment on the worksheet was 90.28%, indicating the good criteria; 2) the teacher’s assessment result of student activities were 96%, meaning that the students’ activities were developed very well when they used using learning instruments; 3) students’ problem-solving skills were enhanced after they experienced the learning using the designed learning instruments; 4) more than 50% of the students provided a positive response on the learning instruments developed; 5) the teacher provided a positive response to the learning instruments developed. As the effectiveness criteria in developing learning instruments have been met, the learning materials developed are effective for use and can improve the problem-solving skills of junior high school students. It is hoped that learning device can trial at some schools which has the same characteristics and implemented by a different teacher.

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