# Development of Student Worksheets Based on a Realistic Mathematics Learning Approach to Improve Problem Solving Ability and Self-Efficacy

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**Abstract.** This research purposes to represent the validity, effectiveness and practicality of student worksheets according to the realistic mathematics learning approach and to build students' self-efficacy and potential for solving mathematical problems. The Tessmer model is employed in the research development model. The topics covered in this research were eighth grade students of SMP Gajah Mada Medan. The results showed that: 1) Worksheets for students that were created using a realistic mathematical method to enhance their problem-solving skills and self-efficacy satisfied valid, practical and effective; 2) An upsurge in the N-gain value from 0.35 in trial I to 0.39 in trial II indicates an improvement in problem solving skills achieved by the use of worksheets designed using a realistic mathematics learning procedure and then 3) Trial I's N-gain value of 0.31 indicates that students' self-efficacy has improved through developed realistic mathematics instruction; in trial II, this value increases to 0.40.

**Keywords:** Worksheet, Tessmer, Realistic Mathematics Learning Approach, Problem Solving, Self-efficacy.

## 1 Introduction

A topic that is crucial to learning is mathematics. Almost all academic disciplines need mathematics. As a result, everyone has to learn mathematics to enable application of it to solve issues in day-to-day existence. In generally, issues cannot be apart from the study of mathematics, due to the capacity for problem-solving is a good indicator of a person's mathematical success or failure. Problem-solving skills are necessary for elementary, middle, and high school students to solve a problem [1]. The reason behind this is that the primary objective of studying mathematics is to acquire problem-solving skills.

Having the ability to solve problems is crucial because humans have been faced with difficult situations from the beginning of time, which requires them to come up with solutions [2]. Furthermore, Mathematical problem solving is currently regarded as an essential component of mathematics, mathematics teaching, and mathematics learning [3]. Rather than relying on recollections of previously solved problems, tasks including problem solving are meant to show the level of mathematical ability needed to complete them [4]. Furthermore, after producing sufficient data about the issue domain to comprehend the challenge, the problem solution procedure starts [5].

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Students' attitudes toward learning mathematics consist of self-efficacy aside from the importance of proficiency in problem-solving. Self-efficacy is an element of psychology that has a significant effect on students' capacity to finish assignments as well as respond to questions. Accurate self-examination becomes essential for completing teacher-submitted assignments and questions. Teachers who possess self-assurance and confidence can facilitate students' work and, beyond that, raise student performance. Self-efficacy in relation to problem solving serves as a tool to assess students' participation in answering problem-solving questions.

Self-efficacy is a person's inner belief regarding his own abilities when facing situations to achieve certain goals in his life [6]. Self-efficacy is the conviction that one can locate, plan, and complete an activity in order to accomplish a goal [7].

To deal with problems that come up in the classroom when teaching mathematics, particularly those involving students' problem-solving skills and self-efficacy and which lead to poor learning outcomes in mathematics, educators need to work to change this. One effort made is to make student worksheets more effective.

Student worksheets in mathematics learning are one of the facilities and infrastructure that teachers can use mathematics to help students and is expected to be effective on students' problem solving abilities in solving mathematical problems. Student worksheets are also learning media that are used simultaneously with other learning resources. Student worksheets with a realistic approach to good learning will provide opportunities for students to improve students' problem solving abilities in solving problems. The teacher as a facilitator is tasked with monitoring student work during the process of completing the student worksheet.

The Realistic Mathematics Approach is a method of teaching mathematics that begins with a real-world problem and progresses to a formal form with a welcoming learning environment through a series of steps known as mathematization [8]. Meaningful learning that will continue to stick in students' minds starting from choosing problems in real life that make sense so that it can make it simpler for students to comprehend and imagine them. The realistic approach is one that encourages raising self-efficacy and problem-solving skills.

A study titled "Development of Learning Materials Based on Realistic Mathematic Education Approach to Improve Students' Mathematical Problem Solving Ability and Self-Efficacy" findings, education that adheres to Realistic Mathematics Education (PMR) and satisfies its successful criteria might increase students' confidence in their ability to solve mathematical issues [9].

Given that the implementation of a realistic mathematics learning strategy may successfully address the weaknesses in students' mathematical problem solving skills and self-efficacy, the researcher believed that conducting research under the title "Development of Student Worksheets Based on a Realistic Mathematical Learning Approach To Improve Problem Solving Abilities and Self-Efficacy".

## 2 Review Of Literature

### 2.1 Problem Solving Ability

Problem solving is the process of using certain steps (heuristics) to identify a problem's solution [10]. Problem-solving is the ability of a student to apply his thought process to solve problems by gathering data, evaluating sources, and assembling the best possible alternatives

to existing answers [11]. Since humans have been faced with difficult problems that require them to find solutions since the beginning of time, problem solving is an ability or skill that is extremely important to acquire [2]. A paradigm that states that problem solving is a human activity that integrates previously learned concepts and rules and is not a general skill can be inferred from the various definitions of the term given above. There are 4 problem solving processes, namely: (1) understanding the problem; (2) planning solutions; (3) carrying out calculations; and (4) checking again [12].

### 2.2 Self-Efficacy

Self-efficacy is an individual's evaluation of his or her capacity to plan and execute a variety of actions that are compatible with work performance (performance) that he or she intended [13]. Self-efficacy refers to an individual's belief that he or she is capable of carrying out a task, achieving a goal, or recognizing an obstacle [14]. Self-efficacy a person's possessions can be measured through 3 dimensions, namely: 1) Dimensions level; 2) Dimensions Generally; 3). Dimensions Strength [15].

### 2.3 Realistic Mathematics Education Approach

Realistic Mathematics Education (RME) was developed from Freudenthal's view which states mathematics as an activity. These tasks include identifying issues, arranging pertinent information, developing mathematical models, resolving issues, and arranging fresh concepts and insights that make sense in the given situation. According to Freudenthal, this activity is called mathematization [16].

The process of learning mathematics through the use of a realistic mathematics method conforms to the traits and tenets of realistic learning. Five categories comprise the processes for teacher and student activities in realistic mathematics approach activities: Understanding; (2) providing an explanation; (3) addressing problems; (4) contrasting or debating potential solutions; and (5) drawing a conclusion.

### 2.4 Student Worksheets

Student worksheets are referred to as printed instructional materials in the shape of paper sheets with information, summaries, and directions for carrying out learning tasks that students must complete in relation to the Basic Competencies that they must accomplish [17]. Student worksheets, according to the Ministry of National Education, are sheets with assignments that students must complete. Typically, these tasks take the form of instructions, outlining the steps to finish a task in relation to the Basic Competencies that the students will attain.

According to the definition given above, student worksheets are defined as sheets with tasks that students must complete as part of the learning process. These tasks may include instructions or steps for completing tasks in accordance with fundamental competencies and indicators of learning outcomes that must be reached.

## 3 Method

Worksheets for students which depend on the realistic mathematics learning approach must fulfill three requirements: they must be legitimate, useful, and efficient. According to the criteria, student worksheets with a realistic mathematics learning approach if they reach the valid level, have a high degree of validity (4≤ Va < 5) as the minimum level of validity. Student worksheets based on a realistic mathematics learning approach are said to be practical if the average learning implementation is at least in the 'Well implemented' category ($3 \leq O_k < 4$). The student worksheet developed is said to be effective if: (1) The student achievement criteria are classical, namely a minimum of 85% of students who take part in the lesson are able to achieve a score $\geq 70$; (2) 80% of students responded positively to the student worksheets based on the realistic mathematics learning approach that was developed.

In this research, the growth in students' problem-solving skills and self-efficacy may be analyzed as follows [18]:

$$\mathrm{N-Gain} = \frac{\mathrm{S_{post}} - \mathrm{S_{pre}}}{\mathrm{S_{max}} - \mathrm{S_{pre}}}$$

**Table 1.** N-Gain Score Criteria.

| Skor N-Gain | Criteria N-Gain |
|---|---|
| $0{,}00 < \mathrm{N-Gain} \leq 0{,}30$ | Low |
| $0{,}30 < \mathrm{N-Gain} \leq 0{,}70$ | Medium |
| $\mathrm{N-Gain} > 0{,}70$ | High |

## 4 Research result

### 4.1 Preliminary Stage

**Preparation Stage.** Researchers are currently conducting material, curriculum, and student analyses in class VIII at SMP Gajah Mada in Medan. Researchers complete this step before beginning the design process.

**Design Stage.** At this point, the researcher used a realistic mathematics learning approach to design the student worksheets. The following procedures are used to implement this design: (a) Choose how the student worksheet will be designed; (b) Preparation of materials; (c) Language preparation.

### 4.2 Prototyping Stage

**Self Evaluation.** At this point, the student worksheet's design was planned by the researcher. self-evaluation of the first prototype created with guidance from the lecturer or supervisor. The evaluation carried out by the researcher independently has previously been confirmed with the supervisor. The results of improvements at this stage are prototype I, followed by the expert review stage.

**Expert Review.** At this point, practitioners and subject-matter experts verify research tools and worksheets for students. When professionals and practitioners validate student workbooks and research tools, the average value of the outcomes is: 1) Student worksheets are 4.32; 2) Self-efficacy questionnaires and problem-solving tests have satisfied the requirements for validity and reliability as assessment tools.

**One to One Trial.** The results of the first prototype were also tested in a small class (one to one) to determine the level of validity. Researchers chose students from class IX-1 with categories of high, medium and low ability, with 2 students each. The outcomes of one-on-one trials are used to determine whether students can understand the prepared worksheets, preventing ambiguity or double meaning so that they can comprehend the meaning and provide accurate answers to questions. The validation result of students' worksheets at the one to one stage was 4.12 which is included in the valid category.

**Small Group Trial.** The prototype was revised using the expert review's feedback and the challenges encountered during testing the initial version, leading to the creation of a second prototype, the results of which were then tested on a small group. The small group in this case is taken from class IX-2, with three students in each of the three ability categories high, medium, and low. So the total number of students who took part in the small group trial was 9 people. The validation result of students' worksheets at the small group stage was 4.13 which is included in the valid category.

**Field Test trials.** During this phase, the student work based on the realism mathematical education challenge of prototype III is presented to the research subject, which is the eighth grade students of SMP Gajah Mada Medan.

### 4.3 Result of Trial I

This study examines three areas of observation to evaluate the utility of student worksheets based on the realistic mathematics learning approach: a) application of learning steps; b) application of social systems; and c) application of management response principles with available support systems. The results of observing the implementation of learning in trial I obtained an average value of 2.97, which is in the poorly implemented category ($2 \leq O_k < 3$). This score does not meet the criteria for achieving practicality of student worksheets in terms of learning implementation.

Trial 1's classical completion of students' problem-solving skills yielded a score of 73.33%, which did not meet the classical completeness criteria. The average self-efficacy questionnaire score was 89.93, meeting the "High" criteria. The average student response fell into the "positive response" category, with 91.67% of responses. These were the indicators of trial 1's effectiveness.

Considering the outcomes of trial I's worksheet analysis for students, data was obtained which showed that students' worksheets could not be said to be practical and effective. For this reason, before trial II was carried out, revisions were made to the student worksheets used in trial I.

### 4.4 Result of Trial II

The second learning implementation trial's observation results were 3.74 (classified as "well implemented"). Trial 2 results showed the following indicators of effectiveness: 1) students' problem-solving abilities in trial 2 had a classical completeness score of 86.67% (criteria "have met classical completeness"); 2) their self-efficacy questionnaire score was 91.30, meeting the "High" criteria; and 3) the average student response fell into the "positive response" category with 92.16% of the total.

### 4.5 Description of Improving Students' Mathematical Problem Solving Abilities Using Student Worksheets Based on the Realistic Mathematics Learning Approach that was developed.

The pre-test average in trial I was 55.63, while the post-test average was 71.30, falling into the "medium" range (0.30 < n-gain ≤ 0, 70) with an average N-Gain of 0.35. Conversely, in trial II, the average score before the test was 60.10, and the score after the test was 75.47, indicating an average N-Gain of 0.39, placing it in the "medium" group (0.30 < n-gain ≤ 0.70). Therefore, based on the proposed realistic mathematics learning strategy, it can be inferred that students' mathematical problem solving abilities from trial I to trial II have grown through the use of student worksheets, as evidenced by the overall average value and average N-Gain value.

### 4.6 Description of Increasing Students' Mathematical Self-Efficacy Using Student Worksheets Based on the Realistic Mathematics Learning Approach that was developed.

With an average N-Gain of 0.31 and a mean of 77.90 before and 89.93 after treatment, the first trial's results fell within the "medium" range (0.30 < n-gain ≤ 0.70). Trial II, in comparison, had an average before treatment of 73.76 and after treatment of 91.30, with an average N-Gain of 0.40, which put it in the "medium" category (0.30 < n-gain ≤ 0.70). Therefore, it can be proved that students' mathematical self-efficacy increased from trial I to trial II using student worksheets based on the established realistic mathematics learning approach, as indicated by the overall average value and average N-Gain value.

## 5 Discussion

Five experts represent the team of experts (validators) that worked on creating the student worksheet. The average total validity of the student worksheets, as reported by the five validators, was 4.32 in their validation results. Both the test and the questionnaire are legitimate, therefore they can be utilized. Based on the trial findings indicating $t_{count} > t_{table}$, the mathematical problem solving ability test instrument and the mathematical self-efficacy questionnaire statement items were also found to be in the valid group. The pre-test's reliability was assessed at 0.802 (very high category), whilst the post-test's mathematical problem-solving skills was rated as extremely dependable at 0.835. Furthermore, the reliability findings of the self-efficacy questionnaire indicated 0.94 (extremely good category).

The preceding analysis findings show that the student worksheet developed has fulfilled the validity standards based on expert/practitioner assessment.

All of the experts who conducted the assessments, known as validators, concluded that the student worksheets created using the realistic mathematics learning approach were appropriate for use with minor modifications. This is corroborated by Akker's assertion that learning resources are considered practical if the validator determines that the developed material can be used [19]. Then, through the learning implementation observation sheet using student worksheet developed was given to an observer at each trial meeting I and II, the result was that the learning implementation observation score in trial I did not meet the practical criteria, namely the average the average observation at the first meeting was 2.87; the second meeting was 2.93; the third meeting is 3.00; the fourth meeting is 3.00 and; the fifth meeting was 3.07, with an average of 2.97 (category "not well implemented"). In contrast, trial II's initial meeting was 3.67, followed by 3.67 in the second, 3.73 in the third, 3.80 in the fourth, and 3.87 in the fifth. In trial II, the average observation result for learning implementation fell into the "well implemented" category at 3.74. As a result, it can be said that the student worksheets created using the realistic mathematics learning approach have satisfied the practical requirements.

Trials I and II yielded results that indicated that the student worksheets developed using the realistic mathematics learning approach met the following criteria for being considered effective: (1) they met the requirements for achieving students' classical problem solving abilities; (2) the average score of the students' mathematical self-efficacy questionnaire falls into the "high" category; and (3) students responded positively to the elements of the student worksheet being developed.

The findings of the pre- and post-test analyses of the participants' capacity to solve mathematical problems in trials I and II show an increase in these abilities. The average scores that students received on the pre- and post-tests for their mathematical problem-solving skills demonstrate the growth in those skills. The average mathematical problem-solving ability in trial I was 55.63, rising to 71.30, according to the examination of the improvement in pupils' capacity to solve mathematical problems in the pre- and post-test data. In trial II, there was an increase in the average score of students' mathematical problem solving abilities from 60.10 to 75.47. According to the average normalized gain, it was also possible to observe an increase in the students' mathematical problem-solving abilities. Specifically, trial I showed an increase with the "medium" criteria ($0.30 < \text{n-gain} \leq 0.70$) and trial II showed an increase with the "moderate" criteria ($0.30 < \text{n-gain} \leq 0.70$). This illustrates how using worksheets for students that are based on the realistic mathematics learning approach has an effect on improving their ability to solve mathematical problems. The research shows that learning grounded in Realistic Mathematics Education that meets successful criteria might improve students' mathematical problem-solving skills and sense of self-efficacy [20].

The examination of the data from the mathematical self-efficacy surveys in trials I and II shows that more students answered the questionnaire. The average scores on students' mathematical self-efficacy questionnaires both before and after receiving treatment that is, student worksheets developed show that there has been an increase in this area. The average mathematical self-efficacy of students prior to receiving treatment in trial I was 89.93, rising to 91.30 in trial II, according to the results of the analysis of raising students' mathematical self-efficacy in trials I and II. Based on the average normalized gain, it is also possible to observe the rise in students' mathematical self-efficacy. In trial I, the average mathematical self-efficacy of students before being given treatment was 77.90 and after being given treatment was 89.93 with an average N-Gain of 0.31. Meanwhile, in trial II the average

mathematical self-efficacy of students before being given treatment was 73.76 and after being given treatment it was 91.30 with an average N-Gain of 0.40. As can be observed, trial I's average n-gain was 0.31, falling into the "medium" range ($0.30 < \text{n-gain} \leq 0.70$). In contrast, trial II's average n-gain was 0.40, falling into the "medium" range ($0.30 < \text{n-gain} \leq 0.70$). Thus, it can be said that student worksheets built around the realistic mathematics learning technique have the potential to raise students' confidence in their mathematical abilities. Increasing students' mathematical self-efficacy is the fulfillment of mathematical self-efficacy indicators towards a better category according to the criteria set through the process of improving student worksheet development and reflection on learning practices. The students' worksheets, which were created using a realistic mathematics learning technique, had an impact on the rise in mathematical self-efficacy. Students' interest in mathematics can be raised by combining instruction with a practical approach to mathematics learning.

## 6 Conclusion

Based on the conversation above, it is possible to deduce that student worksheets using a realistic mathematics learning approach are valid (as evidenced by research instruments and student worksheet validation results), practical (as evidenced by learning implementation observation results), and effective (as evidenced by student responses that are positive and the ability to solve mathematical problems).

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