The Development of Mathematics Learning Tools Based on Realistic Approach of Cooperative Model

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Abstract. This research was development research which aimed to develop mathematics learning tools based on the realistic approach of cooperative model in cube and cuboid materials. They included lesson plans, student books, teacher books, student activity sheets, and Assessment Sheets. The study subjects were students of Class V SDIT Al-Fityan School Gowa. The development procedures used in this research were the Thiagarajan models or 4-D models which included four stages, namely the limitation stage, the design stage, the development stage, and the dissemination or socialization stage. The purpose of this research was to produce learning tools that were valid, practical, and effective based on the realistic approach of cooperative model in cube and cuboid materials. Mathematics learning tools developed had been validated and revised so they were feasible to use.

Keywords: Learning Tool Development, Realistic Mathematics Learning, Cooperative Model

1. Introduction

Improvements in the quality of mathematics learning have been carried out, both by the government and various parties who care about mathematics learning in schools but have not achieved optimal results due to various obstacles in the field [1]. The main challenge is the limited learning tools used by teachers in mathematics learning [2]. Besides, teachers tend to keep using the conventional learning approach [3]. Most of the learning process is still teacher-centered [4]. Therefore, to make the learning process more effective, the purposed activities should facilitate the students to be actively involved. According to [5], students will find it easier to locate and solve difficult concepts if they discuss the problems with their peers. This shows that in-group learning allows students to be more active in solving problems [6].

Cooperative learning is a learning strategy where students learn together in small groups and help each other [2]. In completing the task, each group member cooperates in understanding a subject matter. There are several types of cooperative learning, one of which is the Student Teams Achievement Division (STAD). It pushes students to encourage and help one another to master the skills taught by the teacher. If students want their groups to win a reward, they have to help their groupmates learn the
lesson. Furthermore, they have to motivate their groupmates to do their best, showing the norms that learning is important, valuable, and fun [7].

One of the suitable approaches for this condition is a realistic approach. This was first introduced and developed in the Netherlands in the 1900s by Hans Freudenthal. Realistic Mathematical Education (RME) is an approach of mathematics learning where students solve a problem by connecting their experiences in daily life [8]. Applying this approach in mathematics learning in schools can improve students' understanding and mastery of the material [9]. The realistic learning approach begins with solving the problems around the students by applying their current knowledge so that students have the opportunity to rediscover and reconstruct mathematical concepts [10]. Thus, this is expected to make a major contribution to the students' understanding.

Conducting learning by applying the combination of realistic approach and the Student Teams Achievement Division (STAD) cooperative learning model is an effort that can improve student learning outcomes and creativity [11]. This is because the cooperative learning model of the Student Teams Achievement Division (STAD) is applicable and involves all students regardless of their status as well as involves them as peer tutors. Then, combining it with a realistic approach will allow students to solve the problems by associating mathematics with students' daily experiences [12]. To achieve those objectives, the Graduate Competency Standards (SKL) is therefore set as a criterion that specifies the qualifications of graduates' abilities, including attitudes, knowledge, and skills. Furthermore, to achieve graduate competence, a Content Standard (SI) is set as a criterion related to the scope of material and the level of competence of students to achieve graduate competence at certain levels and types of education. To outline the learning material so that the learning process can run as expected and achieve the competencies as specified in the SKL and SI, learning devices that are following the current curriculum are needed [13]. They have an important role in achieving mathematical goals as they can be used as guides by teachers and students in the learning process so that learning objectives can be achieved [14]. Learning devices provide convenience and can assist teachers in preparing and implementing teaching and learning activities in the classroom [14].

Based on the presented description, the main problem in this research is to develop mathematical learning tools based on the realistic approach of the STAD cooperative model for the cubes and blocks discussion.

2. Methodology

This research is a mathematical learning tool development research that refers to the 4-D model or the Thiagarajan model. The 4-D model consists of 4 stages, namely defining, designing, developing, and distributing [15]. However, in this study, the fourth stage of the model was modified from dissemination to limited socialization. The devices produced in this study are expected to be used by teachers and students as learning guides so that learning objectives can be achieved. Those tools consist of a Learning Implementation Plan (RPP), Teachers' Book (BG), Students' Book (BS), Students' Activity Sheet (LKS), and Assessment Sheet (LP).

This research was conducted at SDIT Al-Fityan School Gowa with the fifth-grade elementary school students as the research subjects. The learning tools development procedure consisted of the defining stage, which began by identifying the fundamental problems faced by elementary mathematics teachers in improving students’ learning achievement, then continued by looking for better and more efficient solutions. Next on this stage, an observation conducted on the characteristics of the fifth-grade elementary school students, including the current abilities and cognitive development level of students. The results were then used as consideration for designing learning tools with a realistic approach to the STAD cooperative model for the matters of cubes and blocks. Afterward, the concept analysis took place, which aimed at identifying, detailing, and systematically arranging the main concepts for students. And then, the task analysis was carried out to identify the main skills needed to design the tasks that students must possess after participating in learning. Task analysis included an understanding of the material, learning objectives, and is a reference for formulating learning objectives and skills that would be developed in learning tools. Completing this stage was the formulation of learning objectives,
namely indicators of learning outcomes achievement, referring to basic competencies. Secondly, the designing stage took place, aiming to produce a design of learning tools for fifth-grade elementary school students for the cubes and blocks matters. The activities carried out at this stage were compiling tests, choosing the learning media used that are adapted to school facilities, choosing the format of the device, and making the initial design of the learning device, which consists of a Learning Implementation Plan (RPP), Teacher's Book (BG), Students’ Book (BS), Student Activity Sheets (LKS), and Assessment Sheets (LP). All learning tools produced at this stage are called the draft I learning tools. The third stage was the developing stage, which aimed to obtain a revised draft of learning tools based on expert input and data resulted from trials. This stage involved the validation of learning tools conducted by experts (validators), resulting in draft II learning tools, and limited trials conducted to the subject research, which eventually produced the Draft III. The revised results of the limited trial were then re-validated by the validators to obtain the final learning tool called draft IV as the final draft. Rounding up the previous stages, the limited socialization stage took place to distribute the developed tools to teachers in the research area to the extent of socialization to attain suggestions or input, which would be taken into account for further improvements.

The research instruments were validation sheets, student activity observation sheets, learning management observation sheets, student response questionnaires to learning activities, teacher response questionnaires, and learning outcomes tests. Afterward, it continued with data analysis, including validation analysis with validity criteria referring to [16] as presented in Table 1 below:

| Category        | Interval of Device Validity Values |
|-----------------|-----------------------------------|
| Very Valid      | $4.5 \leq V \leq 5$               |
| Valid           | $3.5 \leq V \leq 4.5$             |
| Fairly Valid    | $2.5 \leq V \leq 3.5$             |
| Less Valid      | $1.5 \leq V \leq 2.5$             |
| Invalid         | $V \leq 1.5$                      |

The criteria used to decide that the learning tools referring to a realistic approach to the STAD cooperative model, which consists of learning implementation plans, teachers' books, students' books, student activity worksheets, and assessment sheet, is that they should have an adequate degree of validity or V value at least in the “fairly valid” category. If this was not the case, revision should take place by considering validators' suggestions or by evaluating the aspects that are lacking. Afterward, they would be continuously re-validated and re-analyzed so that it met the minimum V value, which was the “fairly valid” category [14].

The process then continued with data analysis on the effectiveness of learning tools, including student learning outcomes data, student activity data, student response data, and management data of mathematics learning with the realistic STAD cooperative model. The researchers determined students' learning completeness by using the learning scores, referring to the Ministry of Education's standard, as shown in Table 2. The minimum passing standard (SKM) that must be met by a student is 83. If students can achieve it, they obtain the individual completeness. Furthermore, If at least 85% of students reach the minimum standard, then classical completeness is achieved (this is determined by the participating school).

| Score   | Category   |
|---------|------------|
| 90 – 100| Very High  |
| 80 – 89 | High       |
| 65 – 79 | Fair       |
| 55 – 64 | Low        |
| 00 – 54 | Very Low   |
The data analysis of the practicality of learning tools conducted using teacher’s response questionnaire results. The category of the practicality of learning tools, using teacher’s response questionnaire results, regarding the realistic STAD cooperative learning model, according to [14], can be seen in Table 3 below.

| Category       | Teacher Responses Interval |
|----------------|----------------------------|
| Very Agree     | $4 \leq RG \leq 4,5$       |
| Agree          | $3,5 \leq RG \leq 4$       |
| Less Agree     | $2,5 \leq RG \leq 3,5$     |
| Disagree       | $1,5 \leq RG \leq 2,5$     |
| Very Disagree  | $RG \leq 1,5$              |

3. Results and Discussion

This research resulted in a product of the realistic mathematics learning tools development adapted to the STAD cooperative model. The device consisted of the Learning Implementation Plan (RPP), Teachers' Book (BG), Students' Book (BS), Students' Activity Sheet (LKS), and Assessment Sheet (LP), adapting to the Thiagarajan Model, which consisted of four stages of defining, designing, developing, and limited deployment. Those stages were as follows:

3.1. Defining Stage

The defining stage consisted of preliminary analysis, student analysis, concept analysis, and task analysis. In the preliminary analysis, the result showed that the mathematics learning achievement at SDIT Al-Fityan School Gowa was still low. The learning process in the fifth-grade of SDIT Al-Fityan School Gowa tended not to provide sufficient opportunities for students to develop their abilities. Students were reluctant to either ask or express their thoughts or opinions about the presented material. The learning process tended to be teacher-centered, and students only listened and wrote down what the teacher said and sometimes did trivialities, such as sleeping and going out of class. Curriculum 2013 (K13) is a curriculum that prioritizes understanding, skills, and character education, where students are required to understand the material, actively involved in discussion and presentation, and show courtesy and high discipline. This provided an overview for researchers about the desired way of presenting learning by using a realistic mathematics learning approach combined with the STAD cooperative model. To carry it out, a suitable device, which adapts to that approach, was then needed. Learning devices provide convenience and assistance to teachers in preparing and implementing teaching and learning activities in the class. Therefore, to undergo the described mathematics learning, appropriate learning tools were needed, including learning implementation plans (RPP), students' books (BS), assessment sheets (LP), and student activity sheets (LKS). On the other hand, teachers were generally not capable enough to make such mathematics learning tools. As that realistic mathematics learning was relatively new in Indonesia and had never been implemented in SDIT Al-Fityan School Gowa, thus the required learning tools were very limited.

In terms of cognitive development, students of SDIT Al-Fityan School Gowa were still at the formal operation stage (11 years and over) with the ability to think abstractly and symbolically. Problems could be solved through the use of systematic experimentation. However, these students still needed concrete objects in learning mathematics. Therefore, this is great to begin mathematics learning with contextual problems that are close to students' daily lives. After analyzing the material in the current curriculum, and taking into account the principles and characteristics of the realistic STAD cooperative learning model, an outline of the material used in this study can be seen in Figure 1.
3.2. Designing Stage
This stage began by compiling a learning outcome test used as a measurement of the success of learning activities. To create the student assessment sheets, the question grid and the scoring guideline were established first. The Benchmark Reference Assessment (PAP) was used as the scoring method, as it mainly focuses on the level of the students' ability to comprehend the tested matters so that the scores showed the proportion of their ability. In this study, learning media were not used because the facilities and infrastructure at the research location were less supportive. The learning implementation plan format was adapted to the 2013 curriculum. Therefore, it contained competency standards, basic competency, indicators of competence achievement, learning objectives, learning materials, STAD cooperative learning model, realistic learning approach, instructional orders, assessment, and assessment instruments. The Student Book and Student Activity Sheet made to be as attractive as possible and provided questions so that students would be interested and eager to learn.

The main activity of this stage was to prepare the learning tools for the Comparison materials of the fifth-grade elementary school. This included the learning implementation plan (RPP), consisting of competency standards, basic competencies, learning achievement indicators (cognitive processes, cognitive products and affective), learning objectives (cognitive processes, cognitive products and affective), cubes and blocks learning materials, STAD cooperative learning model, realistic learning approaches, learning scenarios (initial activities, core activities, and final activities), assessment (techniques, instrument, and procedures). Also, we prepared the Student Book (BS) with cubes and blocks, Student Activity Sheets (LKS) containing the cube and block typical questions, Assessment Sheet (LP), and Final Testing (THB) for the cube and block materials. At this stage, the initial design of the Learning Implementation Plan (RPP) was designed for 3 meetings, while the Student Books, Worksheets, and Assessment Sheets were all prepared for each meeting. The Final Testing along with the grid and key answers prepared for the eventual meeting. All of them were then called draft I.

3.3 Developing Stage
At this stage, the validators validated the draft 1 learning tools. Table 4 presented the validation results, indicating that the learning tools used in this study were valid. This meant that those tools could go through the trial stage. However, based on the validators' inputs, there were still some minor revisions

![Diagram of Learning Tools](image)
to do to the lesson plans, student books, teacher books, student worksheets, and assessment sheets. Those inputs consisted of adding effective objectives and answer keys to the assessment sheet, correcting some writing errors in the student books, sample questions should start with contextual problems, and there should be an instruction in the worksheets for students to independently discover the formula of blocks and cubes volume. After conducting those revisions, the device was then tried out to obtain data of student activities, learning implementation, student responses, teacher responses, and student learning outcomes. The results of this trial were then used to revise the learning tools (draft II) and resulted in draft III learning tools (the final results of the learning tools development). The experimental data would then also be analyzed to determine whether the developed learning device was in the effective category.

| Learning Tools           | Focus of Validation                                      | The Mean Value of The Validator | Conclusion |
|--------------------------|----------------------------------------------------------|--------------------------------|------------|
| RPP (Learning Implementation Plan) | a. Basic Competence and Indicators                      | 4.25                           | V          |
|                          | b. Learning Objectives                                   | 3.57                           | V          |
|                          | c. Learning Materials Completeness                       | 4.5                            | V          |
|                          | d. Learning Materials                                   | 4.13                           | V          |
|                          | e. Learning Order                                        | 4.13                           | V          |
|                          | f. Language Style                                        | 4.17                           | V          |
|                          | **Average Score**                                        | **4.14**                       | V          |
| Student Books            | a. Format                                                | 4.17                           | V          |
|                          | b. Contents                                              | 3.96                           | V          |
|                          | c. Language Style                                        | 4                              | V          |
|                          | **Average Score**                                        | **4.04**                       | V          |
| Teacher Book             | a. Format                                                | 4                              | V          |
|                          | b. Contents                                              | 4.17                           | V          |
|                          | c. Language Style                                        | 3.88                           | V          |
|                          | **Average Score**                                        | **4.02**                       | V          |
| LKS (Student Worksheets) | a. Format                                                | 4.5                            | V          |
|                          | b. Contents                                              | 3.57                           | V          |
|                          | c. Language Style                                        | 4                              | V          |
|                          | **Average Score**                                        | **4.02**                       | V          |
| Assessment Sheets        | a. Contents Validation                                   | 3.08                           | V          |
|                          | b. Language Style                                        | 4                              | V          |
|                          | **Average Score**                                        | **3.54**                       | V          |

Table 4 Learning Tools Validation Results by Validators

Table 5 showed that of 25 students who took the test, 4% of them had a very poor performance, none of them were in poor performance, 8% of them had a mediocre performance, 24% of them were in high performance, and the rest of them (64%) had a very outstanding performance. Table 5 also showed that the number of students achieving the Minimum Completeness Criteria or individual completeness by obtaining scores of 83-100, was 22 out of 25 students or around 88%. Therefore, the number of students who failed to score 83 above, or get a score of 0-82, was only 3 out of 25 students or about 12%. This data showed that classical completeness was achieved by 85%. Thus learning could be concluded to be effective.
**Table 5** Distribution of Frequency and Percentage of Score for Mathematics Learning Outcomes Fifth-grade students of SDIT Al-Fityan School Gowa

| No | Score | Category       | Frequency | Percentage |
|----|-------|----------------|-----------|------------|
| 1  | 0 – 54| Very Poor      | 1         | 4 %        |
| 2  | 55 – 64| Poor          | 0         | 0 %        |
| 3  | 65 – 79| Fair          | 2         | 8 %        |
| 4  | 80 – 89| High          | 6         | 24 %       |
| 5  | 90 – 100| Outstanding / Very High | 16 | 64 % |

### 3.4 Socialization Stage

The bound learning tools were then socialized to SDIT Al-Fityan School Gowa teachers through the KKG (Teacher Working Group), along with the teacher response of the learning tools questionnaire. In this stage, the team explained the learning order according to the lesson implementation plan, which applies the realistic STAD cooperative mathematics learning model. 11 teachers of SDIT Al-Fityan School Gowa attended the activity, where they generally gave positive responses to the learning tools. Table 6 shows the results of the teacher response questionnaire related to the realistic STAD cooperative mathematics learning tools. The review results on table 6 show that the mathematical learning tools obtained an average of 4.27, or "strongly agree" category. Thus, the learning tools met the practicality criteria.

**Table 6** Percentage of Teacher Responses of The Learning Tools

| No. | Statement                                                                 | Response | Score | Note |
|-----|---------------------------------------------------------------------------|----------|-------|------|
| 1   | Teachers feel helped to deliver the learning materials through the realistic STAD cooperative approach. The matters contained in the realistic STAD cooperative approach have met the competency standard and basic competence. | √        | 4     | A    |
| 2   | Teachers feel interested in the realistic STAD cooperative approach      |          |       |      |
| 3   | Is the realistic STAD cooperative approach new in learning process?      | √        | 4     | A    |
| 4   | By the application of the realistic STAD cooperative approach in the learning process, Teachers is now only playing the role of facilitator. The elaboration of learning materials through the realistic STAD cooperative approach is much clearer. The student worksheets that provided are following the materials, which apply the realistic STAD cooperative approach. | √        | 5     | VA   |
| 5   | The assessment sheet that provided is following the materials, which apply the realistic STAD cooperative approach. The learning outcomes test that provided is following the materials | √        | 5     | VA   |
| 6   | √                                                                         | 5       | VA    |
| 7   | √                                                                         |          |       |      |
| 8   | √                                                                         | 4       | A     |
| 9   | √                                                                         | 4       | VA    |
which apply the realistic STAD cooperative approach. The realistic STAD cooperative learning activities facilitates the students to do interaction such as to discussion, inquiry, or presentation with their fellow peers and teachers.

10. The realistic STAD cooperative learning activities facilitates the students to do interaction such as to discussion, inquiry, or presentation with their fellow peers and teachers.

11. The component of RPP, BG, BS, LKS, and LP presented vividly!

12. The realistic STAD cooperative learning activities conducted communicatively.

13. The LKS handed out to the students helps to enhance their learning spirit!

14. The learning orders presented in the RPP is clear!

15. The allocated times is effectively applicable to any kind of learning activities as presented in the RPP!

Rata-rata 4,27 A

Based on the content validation carried out by the validator and limited trials, it can be concluded that the learning tools produced in this study are suitable for use.

4. Conclusions
Mathematics learning tools based on the realistic STAD cooperative model, consisting of Learning Implementation Plans (RPP), Teacher Books (BG), Student Books (BS), Student Activity Sheets (LKS), and Assessment Sheets (LP) have met the valid, effective, and practical criteria. Thus these tools can be used by teachers to teach the cubes and blocks materials to the elementary students.

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