



ISBN : 978 - 602 - 397 - 058
Volume I / 2017, June, 27th 20

PROCEEDING ICMETA

International Conference on Mathematics:
Education, Theory, and Application
December, 6-7th 2016

Department of Mathematics
Faculty of Mathematics and Natural Sciences
Universitas Sebelas Maret

PROCEEDING

ICMETA

International Conference
on Mathematics : Education, Theory, and Application

Mathematics in the Science and Art

Number : 1|27th June 2017
ISBN : 978-602-397-058-2

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The Development of Social Arithmetical Teaching Equipment with Problem Based Learning Model

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ABSTRACT. This research is meant to develop teaching equipment for Social Arithmetical subject through problem based learning model and understand the quality, validity, practicality and affectivity of the teaching equipment. This research uses 4D research approach which had been modified into 3D model, therefore, the research only done through the third step, development. The data used in this research is descriptive quantitative data while the instrument used are validation sheets, test paper and questionnaire. The development result shows that the problem based learning based teaching equipment can be categorized as valid. Students' response of the problem based learning based work book is very positive, therefore, the work book can be categorized as practical. The use of work book has also fulfilled the passing criteria where result shows 82,86% of students pass the test. Based on the developmental research result, can be concluded that the Social Arithmetical Teaching Equipment Problem Based Learning Model can be classified as acceptable as it has already fulfilled the validity, practicality and affectivity criteria.

1. Introduction

Education is an important process to determine individual development as well as social development of a nation. The Government has stated in article 3 of Indonesia Act no 20, 2003, that national education is meant to develop ability and form character as well as attitude of a prestigious nation to develop a smart generation. Education is meant to develop a society with good characters of individual, justice of the nation and a much happier life of each individual.

Individual ability and skills are according to their level of education. It is assumed that the higher someone's education, the higher their knowledge, skills and ability. This pictured that education is function to improve someone's prosperity as education will help someone to avoid fatuity and poverty. Therefore, it is stated that the function of education is to guide children toward their high objective. A good education is an effort toward success in bringing students to achieve their goal.

Teacher is an educator who involve directly with students. Teachers play a very important role in preparing the students to face their future. Teacher's work ethics determine students' success and readiness in global challenge. This profession is unique as teacher play some important role in education namely, teaching, guiding, and connecting value and culture. Therefore, teacher need to develop their ability and creativity to teach. Their competence in material mastery, class management, creating enjoyable teaching environment for the students and their ability to appraise students' ability and achievement are basic criteria to achieve the teaching learning goal.

Based on the interview done by the researcher with mathematics teacher in Junior High school 1 Dagangan Madiun, the researcher found that there are many students

who tend to be passive while teacher explains the material. Some students even fall asleep in class, talking with their classmates, only some of them are active but most of them are not doing their homework. The teaching model implemented in the school is still direct teaching and not suitable with the new 2013 curriculum. Therefore, an interesting teaching process is needed, such as grouping the students, correlating the materials and giving students exercises related to their daily life will most likely activate students' participation in the classroom. It is hope to develop students' motivation during teaching learning process and finally, Mathematics will be an easy subject for them.

To solve all those problems, need to be implemented teaching model which is suitable as an alternative, a model suitable with the new 2013 curriculum and the solution is using problem based learning (PBL). PBL presents students with a problem before the learning is started. Students will be faced to a real problem which will encourage students to analyze, explain and solve the problem. Therefore, students will be trained to think critically in solving the real world problem.

Social Arithmetical is a material given to seventh grade students. This is a materials related to the basic operation of number related to daily life. Therefore, student must understand every material related to social arithmetic as it has close relation with students' daily life. To help students to easily understand the materials, Problem Based Learning Social Arithmetic teaching equipment need to be developed. This will give a chance for the students to find and solve the problem by themselves through active thinking.

Based on the background of the problem, the researcher formulate the problem statement as follow: how is the result of problem based learning based social arithmetic teaching equipment development can be called as valid, practical and effective? The purpose of this research is to create a valid, practical, and effective social arithmetic teaching equipment based on problem based learning.

2. Research Methodology

2.1. Developmental Model

This is a developmental research or more often called as Research and Development called Referensi [2] (R&D) which is an effort to develop prototype of a research based equipment. The developmental model used in R&D is 4-D model stated by Thiagarajan which is known as four-D model [6]. The model consists of 4 steps which is modified into three steps by the researcher namely defining, designing and developing.

2.2. Research Subject

The research is done to 28 seventh grade students of SMP N 1 Dagangan. The researcher used random method for the participant as students of the school have different ability.

2.3. Research procedure

Thiagarajan model consist of 4 steps known as 4-D approach. but the researcher uses only three steps namely defining, designing and developing.

The four steps of the approach is explained below:

2.3.1. Defining Step

The first step of the research is to define and analyze the potential and problem in the research place. The order of the defining step are initial-final analysis, student analysis, concept analysis, task analysis, and specification of objectives.

2.3.2. Designing Step

This step is meant to create the initial draft of the teaching equipment according to the elements of problem based learning. This step is started after the researcher determine the specific learning objective. Designing consist of four basic steps namely test arrangement, media selection, format selection, and preliminary design. For the need of research, observation's sheets, students' response questionnaire, and learning result test are prepared.

2.3.3. Developing Step

This is the step where final manuscript of social arithmetic teaching equipment based on problem based learning is made after revisions of the experts and preliminary restricted testing data is obtained. The activities of the step are:

a. Equipment Validity

Validation is an activity of validate the teaching equipment with certain criteria. The validation is done by expert, lecturer and subject teacher. Validators are those who competent in creating teaching equipment and giving suggestion to the equipment designed.

b. Restricted Testing

This step is done before the field testing where 6 students are prepared by the researcher to test the equipment by using it in learning process.

c. Field Testing

Field testing is done to 28 seventh graders of SMPN 1 Dagangan. This done according to lesson plan made by the researcher. The data obtained in this research are students' response and students' test scores.

2.4.Data Collection Instrument

The instrument used by the researcher in this developmental research is validation sheet, students' worksheets, students' questionnaire response, students' learning test.

2.5.Data Analysis

2.5.1. Teaching equipment validity Analysis

Reference [3], valid means the instrument can be used to measure what is meant to measure. Evaluation technique or test can be called as having a high validity level if it is able to measure what is actually meant to measure. Every aspect of teaching equipment is validated by validator with scoring range from 1 to 4. The

validator will give 1 score if it is bad, 2 if it is not quite good, 3 if it is quite good and 4 if it is very good.

The criteria of validity can be seen in the table 1 below:

Table. 1. Validity Criteria

Answer percentage (%)	Meaning
85,01 – 100,00	Very valid or can be used without revision
70,01 – 85,00	Quite valid or can be used with minor revision
50,01 – 70,00	Not quite valid or need major revision
01,00 – 50,00	Not valid and can't be used

[5]

Teaching equipment can be called as valid after being validated by two validator. If the result of validation by validator obtained quite valid or very valid scoring criteria, the process of developmental research can be continued to the next step, otherwise, the researcher has to revise the draft if the result of validation shows that it has fulfill the criteria of a valid teaching equipment.

2.5.2. *Teaching Equipment Practicality Analysis*

The next data to be analyzed in order to know the practicality of the teaching equipment is the students' response questionnaire. The questionnaire will be given after the teaching process using students' work book. The analysis of students' questionnaire can be called as practical if the positive response of the students reach up to $\geq 70\%$. [1].

The formulae used to measure the practicality level is:

$$RS_{students} = \frac{A}{B} \times 100\%$$

Note :

$RS_{students}$ = students' response percentage/students' response mean

A = the number of students who response

B = the number of students who give their response

[7]

2.5.3. *Teaching equipment affectivity Analysis*

The data used to see the affectivity of the teaching equipment are students' score obtained from the task given after the teaching process using the students' workbook.

According to [1]), valid means the instrument can be used to measure what is meant to measure. An evaluation technique or a test can be called as having a high validity when the technique or test can measure what is meant to measure. Before the questions are given to the students, the questions have to be validated by experts. The aspect to be measured is language used in the equipment are correct according to orthographic and theorem, the cohesion between questions and materials obtained by seventh graders, clarity of questions, and suitability of questions to measure the students' understanding of the materials.

Lesson plans can be called as effective when the number of students who completed the subject classically fulfill the effective criteria or very effective criteria. To get a better understanding of lesson plans implementation affectivity, the researcher presents the illustration in the table below:

Table 2. Affectivity Criteria

No	Affectivity Criteria	Affectivity Level
1.	85,01% - 100,00%	Very valid or vary effective, can be used without revision
2.	70,01% - 85,00%	Quite valid or quite effective, can be used with minor revision
3.	50,01% - 70,00%	Not quite valid or not quite effective, needs major revision
4.	01,00% - 50,00%	Not valid and not effective, can't be used

[5]

Students' work book can be called as effective when students' completeness is $\geq 75\%$ classically [4]. The classical completeness percentage can be measure through this formulae [4].

$$\text{completeness percentage} = \frac{\text{the number students who complete}}{\text{the total number of students}} \times 100\%$$

Teaching equipment in the form of lesson plan (RPP) and students' work book (LKS) can be called as acceptable if it is fulfilled the criteria of validity, affectivity and practicality.

3. *Result and Discussion*

3.1. *Result*

The model used to develop the students' workbook is Thiagarajan, and Semmel Model known as 4-D model with 4 steps. The four steps are defining, designing, developing and disseminating. However, this research inly used three steps namely defining, planning/ designing and developing.

3.3.1. *Defining*

This process is meant to define and analyze the potential and problem of the research. The defining process done in the research are as follow:

a. *Preliminary-final analysis*

The researcher done some observations directly to the students of SMPN 1 dagangan and discussed the matter with the mathematics teacher of seventh graders of SMPN 1 Dagangan. The information obtained are as follow: 1) students' interest in learning mathematics are still very low, 2) restrictiveness of the school in providing supporting book for the students. The researcher also found that the school uses 2013 curriculum in their teaching process where social arithmetic material is presented.

b. *Students' Analysis*

Based on the observation done to the students, the researcher found that the students can be categorized as complete the subject when they get ≥ 75 score. However, based on the daily test and final test score, most of students are still below the standard completeness score. In addition, seventh graders of SMPN 1 Dagangan are mostly between 12-13 years old where according to Piaget, at this age, students are at the stage of developing their formal operational. At this stage, individual is going through the real world and concrete experience toward critical, systematic and logical thinking of the world, and able to develop hypothesis of reasoning. From this opinion, can be concluded that students at this age are already able to solve complex and abstract problem.

c. Material Analysis

This analysis is done by referring to syllabus and lesson plan according to content standard of Junior High School according to the curriculum. Lesson plan used in this research contain two meeting. At this level, researcher done some analysis of the material taught by teacher according to the social arithmetic taught in school. This material is dominated with materials found in our daily life. Based on this analysis, the researcher found the material as follow:

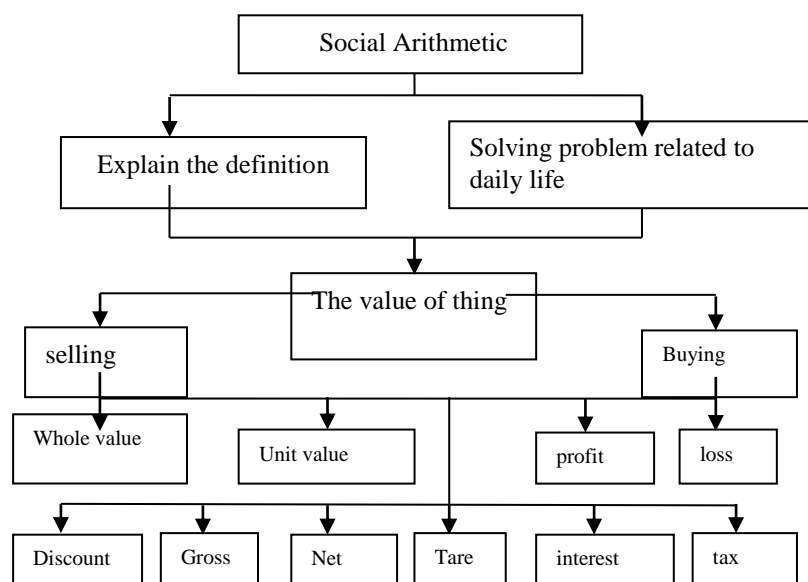


Chart 1. Material Analysis

d. Task Analysis

Task analysis is meant to identify the steps needed by the researcher to achieve the objective. The research objective is to produce students' work book of social arithmetic based on problem based learning model. The task given in the students' workbook are individual and group task related to real daily life problem. Based on the preliminary analysis of social arithmetic, the researcher then created some task as follow:

- 1). Understand the meaning of the whole value, unit value, selling, buying, profit, loss, discount, gross, net, interest, and tax.
- 2). Counting the whole value, unit value, selling price, buying price, profit, loss. Profit and loss percentage, discount, gross, net, tare, interest and tax in real daily life.

e. Teaching objective specification

Based on concept and analysis material result, the researcher determined the learning objectives as follow:

- 1). Explaining the value of thing
- 2). Solving the real daily life problem related to whole value, unit value, selling price, buying price, loss and profit, loss and profit percentage, discount, gross, net, tare, interest and tax.

Based on the above information, the researcher concluded that it is needed to develop a teaching equipment in the form of students workbook with problem based learning model as a tool to help students to understand social arithmetic material completed with daily life problem.

1. Designing

The first step is meant to prepare the teaching equipment prototype. The designing of the learning source including lesson plan and students workbook. The first step in creating the lesson plan is determining the main competency, basic competency, indicator and learning objective continued by designing the teaching steps. The workbook creation is started by collecting the materials, pictures, designing the cover, preface, list of content, and the content material of the workbook. The steps can be explained as follow:

a. Arranging the Students workbook

The material, task and objectives analysis, will be used to arrange the students work book. The first step is done by determining the basic competency. The second step is collecting and arranging the pictures and materials. The third step is paying a great attention to the students work book especially to its title, learning direction, main competency, supporting information, task and steps of evaluation. Below is the example of students workbook design:



b. Determining The Media

The media is determined based on the facilities provided in the classroom such as whiteboard, marker, and ruler, while the basic materials developed is the students workbook.

c. Determining the Format

The students workbook developed in this research is in the form of hardcopy. The format chosen by the researcher to develop the students workbook are:

- 1) The workbook title, 2) students identity namely: name, class and number, 3) title of the material, 4) preface and table of content, 5) learning objective, 6)

the materials according to problem based learning model, 7) individual and group task.

2. *Developing*

The developing of students work book is meant to understand the steps of creating the work book with problem based learning model in social arithmetic material which has gone through some revision based on the suggestion of the validator as well as the restricted test to know the quality of the students' workbook. The process is then continue by creating the real product of social arithmetic students' workbook with problem based learning model. The workbook is created as interesting as possible in order to interest the students in learning the material. The steps of the level are as follow:

a. Expert validation

The step is started by validating the draft by the validator. The validator is an expert of mathematics, Mrs swasti Maharani, M.Pd, lecturer of Mathematics Teaching Department of IKIP PGRI Madiun, Mrs Elis Idaningrum, M.Pd and Mrs Anik Sumbulatin, S.pd as the mathematics teacher of SMPN 1 Dagangan.

Teaching equipment should have valid status before being used. Therefore, if the teaching equipment is not valid, then the researcher will do some revision and validation over to ensure its validity. Based on the validation result of the validators, the lesson plan and the students' workbook is categorized as valid.

b. Limited Testing

The limited testing is done to see whether the teaching equipment developed can be understood easily by the students. The result of students' questionnaire and students' testing showed that the teaching equipment developed can be categorized as effective and practical.

c. Field Testing

The field testing is done in three meeting. The first and second meeting were used by the researcher to present the material to the students using problem based learning model while at the end of the session, students were asked to do exercises by answering some questions. The third meeting was used by the researcher to do some evaluation in the form of learning result test and answering the questionnaire. The result of the questionnaire and learning test shows that the teaching equipment developed can be categorized as practical and effective.

3. *Developmental Result*

The result of this research shows that:

1. The Validity Result Of The Teaching Equipment By The Validator

a. Lesson Plan Validity Analysis Result

The validation sheets by the validators can be seen in the table below

Table 3. Lesson Plan Validity Result after Revision

Validator	V1	V2	V3
Percentage (Vp)	98,33%	96.67%	95,00%
Final Validity Percentage (V)	96,67%		

The final validity percentage result of lesson plan shows 96,67%, therefore, the lesson plan developed in this result can be categorized as valid as it fulfilled the validity level of ≥ 85 .

b. Students' Worksheet Validity Analysis Result

The result of Students' workbook validation done by the validators can be seen in the table below

Table 4. Students' worksheet validation result after revision

Validator	V1	V2	V3
Percentage (Vp)	95,83%	97,22%	97,22%
Final Validation percentage (V)	96,76%		

Based on the student's workbook validation result revised by the researcher show that final validation result is 96,76%, therefore, the students' workbook can be called as valid as it fulfilled the score of ≥ 85 .

c. Practicality Analysis Result

This analysis is done after the students filled the questionnaire related to their appraisal of students' workbook used in the teaching learning process.

1. The Result of Students' Questionnaire after Limited Testing

The students' response to the questionnaire can be seen in the table below

Table 5. Questionnaire response of limited testing

Total score obtained (A)	227
Total criterion score (B)	240
Practicality percentage (P)	94,58%

The table shows that the practicality percentage is 94,58%, therefore, the use of students' workbook in the teaching learning process of social arithmetic subject can be called as practical as it fulfilled the criteria of good response of more than 70% .

2. The Result of Students' Questionnaire after Field Testing

The students' response to the questionnaire after the field testing of the students' workbook can be seen in the table below

Table 6. Questionnaire Result of Field Testing

Total score Obtained (A)	1055
Total Criterion Score (B)	1120
Practicality Percentage (P)	94,20%

Based on the questionnaire response of 28 students show that the practicality response reached up to 94,20therefore, the students' workbook can be called as practical as it fulfilled the practicality positive response of more that 70%.

2. *Affectivity Analysis Result*

The data of affectivity analysis are obtained from the result of students' test scores after the use of students' workbook in the limited testing and field testing where students done some exercises from the workbook. The students' score then categorized as follow:

a. Result Of Problem Validity And Reliability In The Limited testing

Table 7. Students Test Score of Limited Testing

Total Score Obtained	470
Total Whole Score	600
Learning Completeness Percentage	78,33%

The students completeness score obtained from the limited testing is 78,33%. Therefore, can be concluded that the problem based learning based workbook can improve students completeness in learning the social arithmetic materials. The validity of the problem presented in the book based on the limited testing shows that 15 out of 20 problems can be categorized as valid and reliable where they reached the score of up to 0,90. Therefore, the problems presented in the workbook can be called as valid and reliable and can be used in the field testing.

b. Result Of Problem Validity And Reliability In The Field testing

The table below shows the result of Field testing:

Table 8. Students' test Score of Field Testing

Total Score Obtained	2320
Total Whole Score	2800
Learning Completeness Percentage	82,86%

The result of field testing done to seven grader of 7H in SMPN 1 Dagangan shows that 23 students complete the learning process while 5 of them did not. based on the reliability and validity result, 16 out of 20 problems can be categorized as valid and reliable with field testing score of 0,77. Based on the testing result, can be concluded that the students had fulfilled the completeness criteria with classical score of 82,86% and therefore, the students' workbook can be categorized as effective.

4. *Final Product Discussion*

Based on the result of observation, the teaching equipment of Students workbook developed can be called as acceptable if it fulfill three criteria of valid, practical and effective.

1. Validity of students; workbook can be measure from the aspect achieved namely acceptability of preparation, content, and language. After the researcher done some analysis, the researcher found that the validation percentage reached up to 96,76% where it categorized the equipment developed as valid.
2. Problem based learning based students' workbook can be called as fulfill the criteria of teaching equipment if it fulfill the students positive response of up to 70%. The data used by the researcher are obtained from students' response to the questionnaire. The students' response obtained from the limited testing reached up to 94,58% while

the data obtained from the field testing reached up to 94, 20% of positive response. Therefore, the workbook can be categorized as practical.

3. The teaching equipment can be called as effective when the level of completeness achieved by the students upon the use of the equipment is high based on the minimum level of score previously determined which is $\geq 75\%$ from the maximum score of 100.

The research obtained the data of students score as follow:

- a. The mean score obtained by students in the limited testing reached up to 78,33%, while problem validity of the book shows 15 out of 20 problem can be categorized as valid and reliable with score of 0,90.
- b. The mean score obtained by students in the field testing reached up to 82,86% where 16 out of 20 problem presented in the workbook can be categorized as valid and reliable with score of 0,77. the whole data are presented in table 4.11 in the appendix of this paper.

Based on both data, students can be categorized as complete based on the classical standard score of learning. Therefore, can be concluded that the teaching equipment in the form of students' workbook with problem based learning model can be categorized as effective.

4. Conclusion And Suggestion

Based on the research of social arithmetic teaching equipment developed can be concluded that the students workbook developed in the research has fulfilled the validity, affectivity and practicality criteria.

4.1 Conclusion

Based on the research of The Development of Social Arithmetic Teaching Equipment with problem based Learning Model, can be conclude some conclusion as follow:

1. Problem Based Learning Based Teaching equipment Developed in this research can be called as valid based on the validation result done by three validators where it obtained 96,76%.
2. Problem Based Learning Based Teaching equipment Developed in this research can be called as practical where the practicality analysis result done by the three validators stated that the workbook can be used without revision. Students positive response obtained from limited testing and field testing shows 94,58% and 94,20%.
3. Problem Based Learning Based Teaching equipment Developed in this research can be called as effective as shown by the students completeness result based on the limited and field testing where the students' mean score reached up to 78,33% and 82,86%. Therefore, the students' workbook can be called as effective.

4.2 Suggestion

There are some suggestion given to this research namely:

1. The data obtained from the field testing and limited testing obtained in this research still need to be tested in other classes with various condition in order to ensure the quality of the workbook.
2. The material presented in this workbook still need to be developed more in order to ensure its quality.

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