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Developing Mathematics Learning Devices Based On Creative Problem Solving Model in Elementary School

Jusmawati
Universitas Megarezky, Makassar, Indonesia

Satriawati
Universitas Megarezky, Makassar, Indonesia

Akhiruddin
Universitas Megarezky, Makassar, Indonesia

Abdul Rahman
Universitas Negeri Makassar, Makassar, Indonesia

Nurdin Arsyad
Universitas Negeri Makassar, Makassar, Indonesia

Irman R.
Universitas Megarezky, Makassar, Indonesia

***Abstract*---**The aim of this study is to determine the characteristics of teaching materials with a valid, practical, and effective for Creative Problem Solving (CPS) model, to improve mathematics learning outcomes for elementary school students. The teaching materials developed were syllabus, lesson plan, student worksheets and modules. This research used Research & Development (R&D) with a Four-D development model consisting of 4 phases of development, namely: Define, Design, Develop and Disseminate. At the Define phase, the researcher conducts initial analysis, student analysis, concept analysis, performance/task analysis and analysis of the formulation of learning objectives. At the Design phase, the researcher arranges tests, selects formats, and designs the syllabus, lesson plans, worksheets, and modules based on creative problem solving. At the development phase, which consists of the assessment of experts with the results of the validation of teaching materials and the results of the validation of research instruments and the dissemination phase of the dissemination of research tools and results. The research

***Corresponding author**: Rahman, A.; Email: abdul.rahman@unm.ac.id*
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instrument used the implementation of the model, student activities, teacher responses, students' responses and learning outcomes.

***Keywords*---**creative problem solving (CPS), elementary school, learning outcomes, mathematics learning devices, teaching materials.

Introduction

This page should begin with the introduction of your article and follow the rest of your paper. Wilson (1990), stated that the Introduction explains the scope and objective of the study in the light of current knowledge on the subject. State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results. To produce good quality tools, teaching materials must be prepwered cwerefully and in accordance with the rules set out in the standard process (Permendikbud No. 22 of 2016). Teaching materials needed in processing the learning process can be in the form of a syllabus, lesson plans (RPP), student worksheets and modules, instruments needed to measure learning effectiveness in the form of model implementation observation sheets, student activity observation sheets, teacher response, student response and learning outcomes test. Planning for learning devices is designed in the form of a syllabus and lesson plans that refer to the standard process (Permendikbud No.22 of 2016).

The development of teaching materials developed is adjusted to the learning model used (Ahmar & Rahman, 2017). Rusman (2016), argues that teachers were required to choose a learning model that can stimulate the enthusiasm of each student to be actively involved in their learning experience. The learning model used must also be able to make students feel interested in participating in learning activities. To create interesting learning, teachers can relate learning materials to real life, because mathematics is very closely related to problems in everyday life. One of the alternative learning models that exist in the 2013 Curriculum while also requiring students to be creative in student learning is the Creative Problem Solving (CPS) model. The creative problem solving model is the most important thing in solving problems in a creative manner (Sophonhiranrak, et al., 2015).

Wrong solving in effective mathematical learning with a variety of props and skills (Kovari & Rajcsanyi-Molnar, 2020). Creative, effective learning on mathematics requires basic and broad concepts (Ogurlu, 2016). Cerative problem solving is fundamental in the learning process activities, especially in math learning (Rott, 2021). The creative problem solving learning steps are:

- Identifying the problem.
- Finding the problem in accordance with reality or reality so as to obtain the point of the problem.
- Identifying the problem so as to obtain accurate information or data.
- Finding ideas in considering the solution of the problem.
- Finding a solution as a consideration to solve the problem.
- Determining the decision to solve the problem (Kashefi et al., 2012).

Solving problems in everyday life is a very important thing to do in accordance with the steps to solve the problems obtained as expected (Hong, 2013). There are five important stages of the Creative problem solving model:

- Problem definition.
- Problem identification.
- Understanding the problem.
- Finding solutions.
- Solution depletion (Kandemir & Gür, 2009).

Learning devices have an important role in the learning process. With the existence of learning devices are expected to increase students' learning activities so that it has an impact on their learning outcomes. Learning is more interesting more effectively so that students are motivated in the learning process. Learning devices in the form of syllabuses, learning implementation plans, student worksheets and modules are facilities used by teachers and students in the learning process so that students are not saturated and bored following the learning process and the filtered effects that students expect to be motivated, learning runs effectively, students are able to understand their learning so that it impacts their learning outcomes (Probyshevichy, 2021; Nyandra et al., 2018). Solutions to face the challenges that will occur in the learning process by making learning more meaningful and successful so as to develop mathematical learning tools, through this development product is expected to be more effective learning characterized by increased student activity Jafar et al. (2020), positive student response so as to improve student learning outcomes, especially in elementary school students (Bacolod-Iglesia et al., 2021; Hoach, 2021).

Research Methods

This type of research is development research or known as Research & Development (R&D) with a Four-D device development model consisting of 4 stages of development, namely: Define, Design, Develop and Disseminate. This study developed a creative problem solving (CPS)-based elementary school mathematics module. This type of research is Research and Development (R&D). The purpose of this research is to produce elementary school mathematics teaching materials in the form of syllabus, lesson plan (RPP), student worksheets and learning modules based creative problem solving models, which were valid, practical and effective. This development research used 4-D model. The 4-D development research model is developed by Thiagarajan (Trianto, 2015). The 4-D model includes activities, namely:

- Define
- Design
- Develop
- Disseminate

There is a needs analysis, in accordance with the characteristics and conditions of students in elementary schools so that teaching materials were developed in the form of a syllabus, learning implementation plans (RPP), student worksheets

and learning modules with creative problem solving models. After the data was collected, then all the data were analyzed to find out the results. The data analysis used descriptive analysis and the results of the validation of experts, both learning devices and instruments used in the study. The validated teaching materials were in the form of syllabus, lesson plans (RPP), student worksheets and learning modules with creative problem solving models and validated research instruments in the form of observation sheets , student activity observation sheets, teacher response, student response and learning outcomes test (Nugraha et al., 2020; Quyen, 2021).

At the development phase which consists of the assessment of experts with the results of the validation of teaching materials and the results of the validation of research instruments and the dissemination phase of the dissemination of research tools and results. The research instrument used the implementation of the model, student activities, teacher responses, student responses and learning outcomes that were validated, practical and effective, so that the devices and instruments were suitable for use in research. This research is conducted in a limited trial to 9 elementary school students and a product test to 30 elementary school students (Jones, 1997; Taleb et al., 2015).

The results of the validation of teaching materials and research instruments meet the criteria if the average score of at least 2.50 is in the valid and practical category, for the results of research using mathematics teaching materials with the CPL model were: the results of observing the implementation of the model with an average score of at least 2, 50 was in the well-executed category, the results of observing student activities with an average score of at least 2.50 were in the good activity category, the results of the teacher's response with an average score of at least 2.50 were in the good response category, the results of student responses with a score of an average of at least 2.50 was in the category of good student response and learning outcomes in accordance with Minimum Completeness Criteria for elementary school, and classically complete at least 85% (Sung et al., 2016; Cloonan & Fingeret, 2020).

Results and Discussion

Development of mathematics teaching materials for elementary school students with creative problem solving (CPS) models. This development model refers to the 4-D development model which is divided into 4 phases, namely the definition phase, the design phase, the development phase and the dissemination phase. Each phase of development is in accordance with the steps for developing elementary school mathematics teaching materials in the form of syllabus, lesson plans, worksheets and modules with creative problem solving (CPS) models (Reiter-Palmon & Illies, 2004; Kandemir & Gür, 2009).

Define phase

Based on the results of initial observations there were problems in learning mathematics, showing the limited references of teachers in developing teaching materials so that the devices used in the learning process were limited, so there is a lack of interaction with students so that students were not required to solve

learning problems so that it has an impact on learning outcomes. Therefore, teaching materials were developed that were able to solve problems in learning and learning to run effectively and efficiently, namely by developing teaching materials in accordance with the curriculum set in elementary schools in the form of syllabus, lesson plan (RPP), student worksheets and modules with creative problem solving models (Lemos & Veríssimo, 2014; Barnard, 2004).

Design phase

Development activities carried out at the planning phase by designing learning devices. In designing learning tools, choose the appropriate media and format. In the selection of tools in the form of syllabus, lesson plans, worksheets and modules, the design of these devices is in accordance with the steps of the creative problem solving (CPS) learning model. Guidelines for preparing teaching materials in accordance with Permendikbud No. 22 of 2016.

Development phase

The teaching materials developed in the form of syllabus, lesson plans, worksheets and modules aim to produce mathematics teaching materials with creative problem solving (CPS) models that have been validated and used in limited trials and product tests. The results of the limited trial validation were presented in table 1.

Table 1
Learning tool validation results for limited trial

No	Device	Validator I	Validator II	Validator III	Average
1	Syllabus	4.01	3.98	3.99	3.99
2	Lesson Plan	4.02	4.02	3.99	4.01
3	Students' Worksheet	4.04	3.97	4.00	4.00
4	Module	4.04	4.08	4.04	4.05

Based on the table 1 (results of the validation of learning devices for a limited trial) consisting of Syllabus, Lesson Plan (RPP), Student Worksheet and Module with Creative Problem Solving (CPS) model shows that the average value of each learning device is in the valid category. Based on the figure 1, the analysis of the results of the validation of learning devices, it can be concluded that learning devices based on Creative Problem Solving (CPS) models developed include: Syllabus, Learning Implementation Plans (RPP), Student Worksheets and Modules, according to experts, have met the validity criteria, were in the valid category and can be used in the field with minimal revision (Rasch & Schnotz, 2009; Aziz et al., 2012).

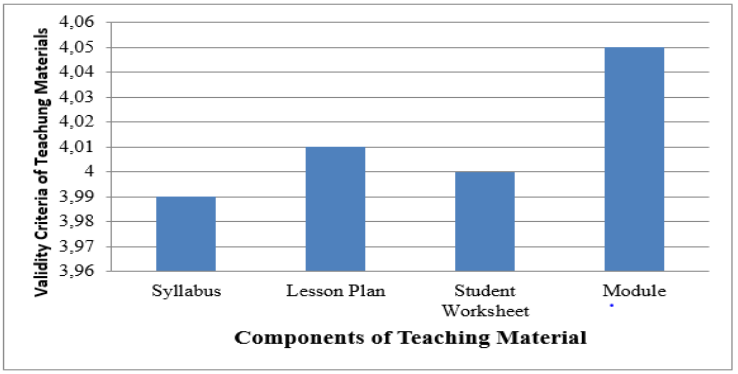

Figure 1. Validity criteria of teaching materials of limited trial

Instruments that used in this study consisted of: 1) Model Implementation Observation Sheet, 2) Student Activity Observation Sheet, 3) Teacher Response, 4) Student Response and 5) Learning Outcomes. As for the results of the validation of the research instrument experts were presented in table 2.

Table 2
Research instrument validation results

No	Research Instruments	Validator I	Validator II	Validator III	Average
1	LO Execution Model	4.09	4.12	4.10	4.10
2	LO Student Activities	4.04	4.13	3.99	4.05
3	Teacher's Response	3.97	4.19	4.01	4.06
4	Student Response	3.98	3.97	4.17	4.04
5	Learning outcomes	4.08	4.05	4.07	4.07

From the table of the results of the validation of the research instrument consisting of the model implementation observation sheet, student activity observation sheet, teacher response, student response and learning outcomes test were in the valid category, indicated that the score was valid. The average of each research instrument was valid category. Based on the figure 2, the analysis of the results of the validation of research instruments consisting of: observation sheets , student activity observation sheets, teacher response, student response and learning outcomes test, it can be concluded that this instrument can be used in development research.

Limited trial results
CPS model implementation results

The results of observing the implementation of the model during learning activities with teaching materials and CPS learning models in elementary school mathematics lessons by two observers were briefly presented in the table 3.

Table 3
Result of observation of model implementation

No	Observer	Meeting I	Meeting II	Meeting III	Meeting IV	Average
1	Observer I	3.80	3.73	3.73	3.73	3.75
2	Observer II	3.67	3.53	4.07	3.60	3.72
			Total			3,735

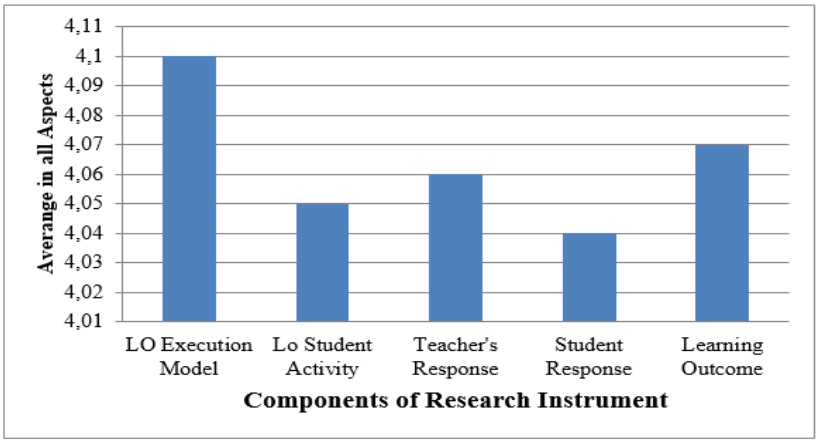

Figure 2. Validity average in all aspects of limited trial

Based on the table 2, it can be seen that the assessments of the two observers at the first to fourth meetings showed that the average value of the model implementation was 3,735 in the category good. This shows that learning by using teaching materials with the CPS model was carried out well.

Student activity observation results

The results of observing student activities during learning activities with teaching materials and CPS learning models in elementary school mathematics lessons by two observers were briefly presented in the table 4.

Table 4
Student activity observation results

No	Observer	Meeting I	Meeting II	Meeting III	Meeting IV	Average
1	Observer I	3.67	3.93	3.67	3.60	3.71
2	Observer II	3.73	3.93	3.53	3.73	3.73
			Total			3.72

Based on the results of observations of student activities during the learning process with CPS tools and models in elementary school fifth grade in mathematics class in table 4, it can be seen that the assessments of the two observers at the first to fourth meetings showed an average of 3.72 student activities in the good category. This shows that the student's activities when

learning took place using teaching materials with the CPS model were in the good activity category.

Teacher's response

The results of the teacher's response questionnaire during learning activities with teaching materials and CPS learning models in elementary school mathematics lessons by two teachers were briefly presented in the table 5.

Table 5
Teacher response questionnaire results

Response	Average Score	Average of Teachers' Response
Teacher I	3.75	3,835
Teacher II	3.92	

Based on the results of the teacher's response questionnaire after the learning process with CPS tools and models in the fifth grade elementary school mathematics subject in table 5, it can be seen that the average value of the responses of the two teachers was 3.835 in the good response category. This shows that the teacher's response when learning took place using teaching materials with the CPS model was in the good response category.

Student response results

The results of the student response questionnaire after the learning process with the CPS device and model in the fifth grade elementary school mathematics subject with an average student response value of 3.87 were in the good response category. This shows that the student's response after the application of learning using teaching materials with the CPS model is in the good response category.

Learning outcomes

Data about students' mathematics learning outcomes were used to determine the value of students' mathematics learning outcomes after learning activities with the CPS model learning device in mathematics subjects, the results of the limited trial were briefly presented in the table 6.

Table 6
Frequency distribution of student learning outcomes

Absolute Value	Frequency	Percentage	Category
86-100	0	0%	Very good
71-85	1	11.11%	Well
56-70	4	44.45%	Enough
41-55	3	33.33%	Not enough
<40	1	11.11%	Very less

Based on the table 6, it shows that student learning outcomes after being treated with CPS model teaching materials in mathematics subjects, this is a limited trial conducted on 9 elementary school students with an average of being in the sufficient category.

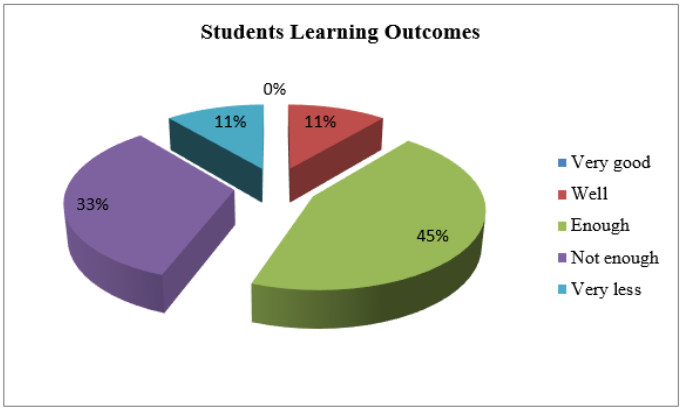

Figure 3. Student learning outcomes

Based on the figure 3, it shows that student learning outcomes after being treated with CPS model teaching materials in mathematics subjects, this is a limited trial conducted on 9 elementary school students, the percentage of learning outcomes shows that 0% is in the very good category, 11.11% were in the good category, 44.45% were in the sufficient category, 33.33% were in the less category and 11.11% were in the very poor category. Classical completeness in a limited trial of the learning process with devices developed with the CPS model can be seen in the table 7.

Table 7
Learning outcome data

Score	Frequency	Percentage	Category
65-100	5	55.55%	Complete
<65	4	44.45%	Not Complete

Based on the table 7, it shows that there were 5 students who have completed the Minimum Completeness Criteria and 4 students who have not completed under the Minimum Completeness Criteria, individually in the fifth grade elementary school mathematics subject, it means that students have not reached the classical criteria of completeness that have been set, namely 80%, students who complete, meaning that it does not meet the criteria that have been set in elementary school mathematics subjects, so that further development is carried out based on the results of revisions and extensive product testing is carried out.

The results of product test validation

Teaching materials that have been tested were limited and based on input and revision results were developed to produce tools in the form of syllabus, lesson plans, worksheets and modules aimed at producing mathematics teaching materials with creative problem solving (CPS) models that have been validated

and used in product testing. The results of product test validation were presented in table 8.

Table 8
Teaching materials validation results for product test

No	Teaching Materials	Validator I	Validator II	Validator III	Average
1	Syllabus	4.86	4.89	4.89	4.88
2	RPP	4.87	4.86	4.88	4.87
3	LKS	4.90	4.92	4.91	4.91
4	Module	4.91	4.89	4.89	4.90

Based on the table of results of the validation of teaching materials for product testing or broad device testing (table 8) consisting of Syllabus, Lesson Plan (RPP), Student Worksheet and Module with Creative Problem Solving (CPS) model shows that the average value of each learning device is in the very valid category.

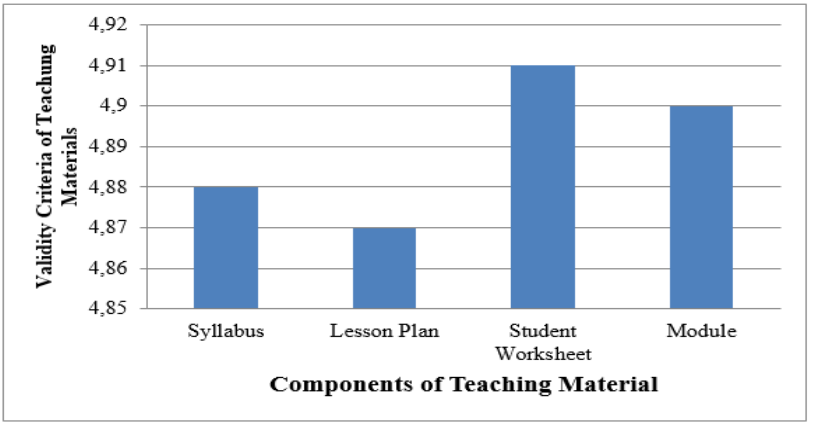

Figure 4. Validity criteria of teaching materials of product test

Based on the figure 4, the analysis of the results of the validation of learning devices, it can be concluded that learning devices with Creative Problem Solving (CPS) models developed include: Syllabus, Learning Implementation Plans (RPP), Student Worksheets and Modules, according to experts, have met the validity criteria, were in the very valid category and can be used in the field without any revision. Instruments that used in this study consisted of: 1) Model Implementation Observation Sheet, 2) Student Activity Observation Sheet, 3) Teacher Response, 4) Student Response and 5) Learning Outcomes. As for the results of the validation of the research instrument experts were presented in table 9. From the table 9 consisting of the model implementation observation sheet, student activity observation sheet, teacher response, student response and learning outcomes test were in the very valid category, indicating that the average value of each research instrument is in the very valid category.

Table 9
Research instrument validation results

No	Research Instruments	Validator I	Validator II	Validator III	Average
1	LO Execution Model	4.91	4.94	4.91	4.92
2	LO Student Activities	4.89	4.90	4.90	4.90
3	Teacher's Response	4.92	4.91	4.91	4.91
4	Student Response	4.91	4.93	4.92	4.92
5	Learning outcomes	4.88	4.92	4.93	4.91

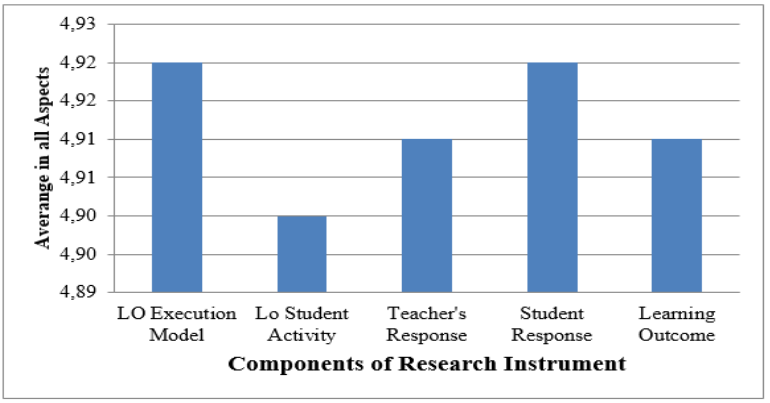

Figure 5. Validity average in all aspects of product test

Based on the figure 5, the analysis of the results of the validation of research instruments consisting of: observation sheet, student activity observation sheet, teacher response, student response and learning outcomes test, it can be concluded that this instrument can be used in development research.

Product test results
CPS model implementation results

The results of observing the implementation of the model during learning activities with teaching materials and CPS learning models in elementary school mathematics lessons by two observers were briefly presented in the table 10.

Table 10
Result of observation of model implementation

No	Observer	Meeting I	Meeting II	Meeting III	Meeting IV	Average
1	Observer I	4.53	4.80	4.87	4.93	4.78
2	Observer II	4.73	4.80	4.87	4.93	4.83
			Average			4,805

Based on the table 10, it can be seen that the assessments of the two observers at the first to fourth meetings showed that the average value of the implementation

of the model is 4.805 which is in the very good category. This shows that learning by using teaching materials with the CPS model is very well done.

Student activity observation results

The results of observing student activities during learning activities with teaching materials and CPS learning models in elementary school mathematics lessons by two observers were briefly presented in the table 11.

Table 11
Student activity observation results

No	Observer	Meeting I	Meeting II	Meeting III	Meeting IV	Average
1	Observer I	4.60	4.80	4.87	4.93	4.80
2	Observer II	4.60	4.73	4.80	4.87	4.75
			Average			4,775

Based on the results of observations of student activities during the learning process using CPS tools and models in elementary school mathematics (table 11), it can be seen that the assessments of the two observers at the first to fourth meetings showed an average value of 4,775 student activities in the very good category. This shows that the student's activities during the learning process using teaching materials with the CPS model were in the very good activity category.

Teacher's response

The results of the teacher's response questionnaire during learning activities with teaching materials and CPS learning models in elementary school mathematics lessons by two teachers were briefly presented in the table 12.

Table 12
Teacher response questionnaire results

Response	Average Score	Average
Teacher I	4.83	4.79
Teacher II	4.75	

Based on the results of the teacher's response questionnaire after the learning process with CPS tools and models in elementary school mathematics (table 12), it can be seen that the average value of the responses of the two teachers is 4.79 in the very good response category. This shows that the teacher's response when learning takes place using teaching materials with the CPS model is in the very good response category.

Student response results

The results of the student response questionnaire after the learning process with CPS tools and models in elementary school mathematics subjects with an average student response value of 4.89 were in the very good response category. This

shows that the student's response after the application of learning using teaching materials with the CPS model was in the very good response category.

Learning outcomes

Data about students' mathematics learning outcomes were used to determine the value of students' mathematics learning outcomes after learning activities with the CPS model learning device in mathematics subjects, the product test results were briefly presented in the table 13.

Table 13
Frequency distribution of student learning outcomes

Absolute Value	Frequency	Percentage	Category
86-100	26	87%	Very good
71-85	4	13%	Well
56-70	0	0%	Enough
41-55	0	0%	Not enough
<40	0	0%	Very less

Based on the table 13, it shows that student learning outcomes after being treated with CPS model teaching materials in mathematics subjects, this is a product test conducted on 9 elementary school students with an average of being in the very good category.

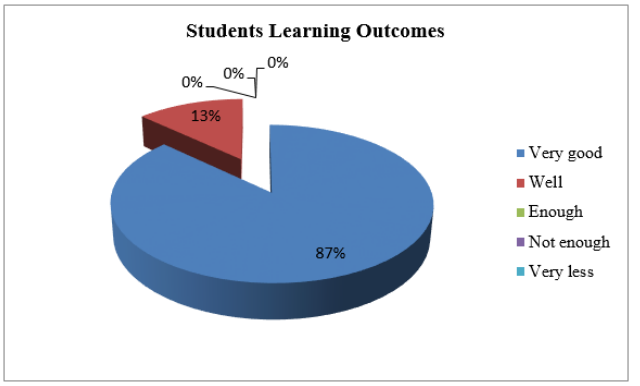

Figure 6. Students learning outcomes of product test

Based on the figure 6 shows that student learning outcomes after being treated with CPS model teaching materials in mathematics subjects, this is a product test conducted on 30 elementary school students, the percentage of learning outcomes shows that 87% were in the very good category, 13 % were in the good category, 0% were in the sufficient category, 0% were in the less category and 0% were in the very poor category. Classical completeness in product testing of the learning process with devices developed with the CPS model can be seen in the table 14.

Table 14
Learning outcome data

Score	Frequency	Percentage	Category
65-100	30	100%	Complete
<65	0	0%	Not Complete

Based on the table 14, it shows that all student learning outcomes reach the KKM, student learning outcomes with teaching materials with creative problem solving (CPS) models that have been thoroughly developed classically, this shows that teaching materials were effective in improving elementary school student learning outcomes.

Dissemination phase

The phase of disseminating teaching materials with creative problem solving (CPS) models, namely products in the form of Syllabus, Lesson Plan, Student Worksheet, Modules and the results of development research were distributed to school principals, teachers, and students.

Conclusion

This study can be concluded that the development of creative problem solving (CPS) teaching materials is effective in improving the mathematics learning outcomes of elementary school students.

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