Journal of Physics: Conference Series

PAPER • OPEN ACCESS

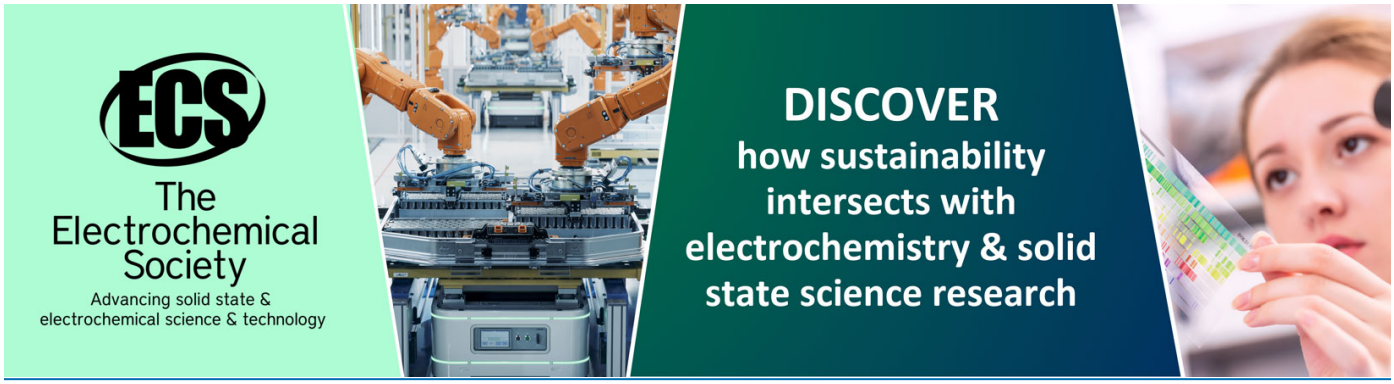
Developing mathematics learning materials of fifth grade of elementary school integrating mathematics game, problem posing, and manipulative

To cite this article: A W Kurniasih *et al* 2020 *J. Phys.: Conf. Ser.* **1567** 022089

View the article online for updates and enhancements.

You may also like

- Study on Influence of the use of energy on living condition
Yang Chen
- The Development of Electrolytes with Flame Retardant Additives for Multiple Lithium-Ion Chemistries
Frederick C. Krause, John-Paul Jones, Jessica Soler et al.
- Study of HRS-WC mixture performance using the waste of crude palm oil ash as filler
Daud, R Rachman and J Tanijaya



This content was downloaded from IP address 3.17.184.90 on 03/05/2024 at 23:24

Developing mathematics learning materials of fifth grade of elementary school integrating mathematics game, problem posing, and manipulative

A W Kurniasih*, I Hidayah and M Asikin

Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Indonesia

*Corresponding author: aryworo.mat@mail.unnes.ac.id

Abstract. The purposes of this study were obtained the validity, practicality, and effectiveness of the learning tools that have been integrated teacher stimulus that has been formulated in the design of mathematics learning of fifth grade of elementary school. This development research refers to the 4-D development model developed by Sivasailam et al. (1974) consisted of 4 stages of definition, design, development, and disseminate. This research did not reach the fourth stage. The learning model used is 1) Teams Games Tournament model with the research subjects of Plalangan 1 public elementary school students as many as 44 students with integrated stimulus were problem-posing and the use of manipulative teaching aids, 2) Creative Problem Solving with research subjects Pakintelan 1 public elementary school students with 25 students with stimulus that is integrated were a mathematical game and the use of manipulative. The research instruments were mathematical games, math game discussion sheets, test sheets, problem-posing discussion sheets, tests containing problem posing, student response questionnaire sheets, learning material validation sheets, and learning implementation sheets. The results showed that the learning materials in Plalangan 1 that integrated stimulus problem posing and the use of manipulative were valid, effective, and practical. The results showed that the learning tools in Pakintelan 1 that integrated the stimulus of mathematical games and the use of manipulative were valid, effective, and practical. The further research by applying mathematical stimulus games, problem posing, and the use of manipulative to describe high-level thinking of elementary school students.

1. Introduction

Mathematics is considered as a frightening subject for elementary school students. Many elementary school students look negatively towards mathematics [1] so that affects mathematical learning achievement. Some literatures show that there are students who think that mathematics is difficult, there are students who think that mathematics is important, and there are students who claim that learning mathematics is not fun (e.g., [2]). Mathematics is useful and relevant but mathematics is also boring [3]. Many elementary school students also experience mathematical anxiety. Few adults want to remember their pleasant childhood experiences about mathematics. Many people easily remember the difficulties they face when dealing with mathematics and many non-teacher adults easily communicate their dislike of mathematics [4]. This fact raises children's dislike of mathematics. Attitude towards mathematics is defined as a liking or disliking of mathematics, a tendency to engage in or avoid mathematics activities, a belief that one is good or bad at mathematics and a belief that mathematics is useful or useless [5].

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

Research by [6] shows that the teacher's behavior towards the students gives a great influence on the students' behavior towards mathematics. Mathematics teacher who shows leadership spirit, friendly/helping and understanding the students encourages the students to have an attitude of liking mathematics. This fact is compounded by the students' views that mathematicians are anti-social individuals, individual, intelligent people but strange, and describes mathematics teachers as someone who angry and unfriendly [7]. Research shows that most of the students do not like mathematics because of its presence in the class [8].

The information above makes someone feel heavy learning mathematics. Learning mathematics will be successful if the students go through an exploratory, challenging, and collaborative learning process [9]. Mathematical thinking is a powerful predictor for seeing someone's academic success at the school ([10], [11], [12]). The teacher has to plan mathematical learning that makes the students feel challenged, interested, willing to explore. Research by [13] found the fact that mathematical learning will succeed when focusing on the students' interests and learning experiences. In general, children have a high curiosity, have an interest in the process of solving puzzles and trying to solve the problems [14]. Many activities that can be planned by the teacher so that the students are interested in learning mathematics, for example learning guided discovery [15], the use of games in the class to improve the students' achievements and learning motivations [16], game-based learning that can be used to develop the students' intrinsic motivation and critical thinking abilities in the class ([17]; [18]), fun activities and games that can be applied in the learning so that the children have the opportunity to learn basic math skills in a fun way [19]. In the constructivist view which is the 21st-century educational trend, the teachers must provide a learning environment that focuses on the students in the sense that the students become active, supporting the thinking skill and social interaction. In essence, mathematical learning at the level of basic education must use appropriate learning practices, for example, the mathematical concepts and ideas must be approached with the use of ''context'' problems so that mathematics becomes useful and meaningful for the children and relevant to their experiences [20]. Finally, the students can develop their mathematical abilities.

Based on the preliminary studies at Plalangan 1 public elementary school and Pakintelan 1 public elementary school from August to December 2018, obtained the data that the fifth-grade teachers never raise play activities or use mathematical games in the learning. Mathematical games can be categorized as mathematical activities that have the potential to enhance mathematical knowledge and skills[21]**.** Mathematical games are well suited to the constructivist view because it involves the active participation of the learners [22], the students form their knowledge [23], and it is student-centered learning, not teacher-centered learning. Games also support various educational outcomes such as spatial and visual skills [24], analogical reasoning [25], problem- solving skills [26]. Many experts define the game. A game as a rule-based system with a variable outcome, where different outcomes are assigned different values, the player exerts effort to influence the outcome, the player feels emotionally attached to the outcome, and the consequences of the activity are negotiable, defined by [27], game as a problem-solving activity, approached with a playful attitude [28]. The teachers need to consider the use of mathematical games in the learning process to develop the students' problem solving and critical thinking skills [29].

Still based on the preliminary studies at those public elementary schools, obtained the data that both of fifth-grade teachers apply problem posing in mathematical learning. The form of problem-posing made by the students is problem-posing that is free to do by friends and making the questions of the problem with the questions that are not stated. However, the problem-posing strategy applied by the teacher has not used the other variations. Many problem-posing stimulus strategies made the teacher that is making problem-based on the context that has been given, making problem-based on the calculation given, making a problem based on the solution that has been given, making sub-problem in solving the larger problem, making the question "what if" [30].

The stimulus given by the teacher in mathematical learning in the fifth-grade elementary school in the form of problem-posing can be used by the teacher as a means of knowing how the students think. Problem posing in the mathematical class is a means of expressing the students' mathematical thinking

[31]. The more information about what the students think and know then the teacher has information to create an effective learning environment for the students. The existence of teacher's knowledge about the students' thinking has an impact on the quality of learning that the teachers do in the class and the students' learning processes. Based on the preliminary study, it is found that the teacher gives several numbers in the form of integers, decimal numbers, and percents. As many as 44 students are asked to make the problems of multiplication and division of fractions and percents. Numbers given by the teacher were 3;5;6;8;12;15;20;25;20%; 25%; 30%; 45%; 0,20; 0,25; 0,45.

Questions made by most of the students are still simple. The questions made by the students are still in the easy category because they only involve an operation (multiplication/division), questions that are made only ask to do the calculation, the workmanship only displays the computational skill. It shows that the students' mathematical thinking abilities still need to explore. Mathematical problems made by the students with high mathematical ability differ from the mathematical problems made by the students with neither high nor less high mathematical ability in terms of computational skill applied, number of operations used, complexity of number systems, planning of the questions, the workmanship of the problems, the smoothness of the students in applying the rules and algorithms, and the language used [32].

Questions made by most of the students only rely on computational skills. This fact is supported by research [32] which stated that the children prefer to make mathematical problems directly related to the computational skill. Questions made by the students include "calculate $\frac{3}{5}\text{x}\frac{25}{100}$ and calculate $0{,}20:20\%$". The students' work results are $\frac{3}{5}\text{x}\frac{25}{100}=\frac{75}{500}=\frac{15}{100}$ and $0{,}20:20\%=\frac{20}{100}:\frac{20}{100}=\frac{20}{100}\text{x}\frac{100}{20}=\frac{2000:1000}{2000:1000}=\frac{2}{2}=1$

Still based on the preliminary research at Plalangan 1 public elementary school and Pakintelan 1 public elementary school is obtained the fact that the use of mathematical teaching aid in the mathematical learning in the class is rarely done. Factly, many mathematical concepts are abstract and elementary school students still have difficulty thinking abstractly. The manipulative teaching aid is important as a medium to help thinking, that is the transition from the concrete understanding to a more abstract understanding of content [33]. Manipulatives are defined as concrete materials, and their virtual equivalents, that foster learning by engaging students physically and visually [33]. Manipulative can come in a variety of forms and they are often defined as "physical objects that are used as teaching tools to engage students in the hands-on learning of mathematics".

Based on the things above, the recommendations of this preliminary study were the integration of problem-posing with a variety of variation, mathematical games, and the use of manipulative teaching aid to developing thinking of fifth-grade elementary school students. Therefore, the formulation of this study is: how is the validity of learning tools that have been integrated into teacher's stimulus that has been formulated in the design of fifth-grade elementary school mathematical learning? how is the practicality of learning tools that have been integrated into the teacher's stimulus that has been formulated in the implementation of fifth-grade elementary school mathematical learning? and how is the effectiveness of learning tools that have been integrated into the teacher's stimulus that has been formulated towards the development of the students' thinking of the fifth-grade elementary school mathematical learning?

2. Methods

This development research refers to the 4-D development model which is developed by [34] consisting of 4 phases of defining, designing, developing, and disseminating. The research instruments are lesson plan, mathematical game, student's discussion sheet, test, students' response questionnaire, validity sheet of the lesson plan with mathematical games and manipulative teaching aid stimulus, validity sheet of the lesson plan with problem-posing and manipulative teaching aid stimulus, validity sheet of the lesson plan with mathematical game and manipulative teaching aid stimulus, validity sheet of the discussion sheet (problem-posing), validity sheet of mathematical game, validity sheet of the discussion sheet (mathematical game), validity sheet of the test (mathematical game), and validity sheet of the test

(problem-posing). Due to time constraints, this study only takes up to three phases, that is defining, designing, and developing. The study is conducted in two elementary schools, namely the fifth-grade of Plalangan 1 public elementary school and fifth-grade of Pakintelan 1 public elementary school. The disseminating phase on a larger study scale is not carried out.

3. Result and Discussion

3.1. Result

The defining phase aims to get information about the needs, development supporting theory, curriculum, students, and learning materials needed in the learning process. This phase is conducted to know the condition in the field (Plalangan 1 and Pakintelan 1 public elementary school). Based on the observation of the learning during preliminary studies in both schools, it seems that the thinking stimulus used by the teacher are guided question and simple problem posing. Learning at the school uses the 2013 Curriculum. Teacher's perceptions about the scientific approach are good in the activities of observing, questioning, associating/processing information/reasoning, and communicating, but there is still a lack of variation in the facilitation of collecting information activity.

The designing phase aims to prepare a prototype of the learning tools. Learning tool at fifth grade of Plalangan 1 public elementary school is a lesson plan with Creative Problem Solving model that integrates the stimulus of problem posing and manipulative teaching aid, students' discussion sheet containing problem posing, manipulative teaching aid (net of cube and cuboid, the volume of cube and cuboid), and test. Learning tool at the fifth grade of Pakintelan 1 public elementary school is a lesson plan with TGT model that integrates the stimulus of mathematical game and manipulative teaching aid, mathematical games, manipulative teaching aid (nets of cube and cuboid, manipulative teaching aid of the cube and cuboid volume), and test. The tool that resulted in this phase is called by draft 1.

The next phase was the developing phase. There are two activities in this phase, namely validation and test trial in the class. In this phase, the instruments used are the validation sheet of the lesson plan, the validation sheet of the mathematical game, the validation sheet of the test, validation sheet of the discussion sheet (containing problem-posing). Draft 1 is consulted with experts. Learning tools are said to be valid if they require the content validity and construct validity determined by experts. The experts are the fifth-grade teachers at Plalangan 1 and Pakintelan 1 public elementary school, that is Mrs. Arry Susanti and Mrs. Siwi Intan P. Both of teachers give the suggestions related to the mathematical game activity, the problems listed on the discussion sheet, the problems on the test adjusted with the characteristics of the students at the school. Teachers' suggestions are used to improve the product. The revised product is called by the final draft.

Description of the average value of lesson plan validation uses the category scale as follows.
$1{,}00 \leq R < 2{,}00$: not good (not appropriate, unclear, not efficient, not operational)
$2{,}00 \leq R < 3{,}00$: less good (appropriate, clear, not efficient, not operational)
$3{,}00 \leq R < 4{,}00$: pretty good (appropriate, clear, efficient, not operational)
$4{,}00 \leq R < 5$: good (appropriate, clear, efficient, operational)
$R = 5$: very good (appropriate, clear, efficient, operational and perfect)
Criteria: The lesson plan is said to be valid if the average value of learning tool validation is in the category at least "good".

Expert validation of lesson plan at Pakintelan 1 public elementary school is the fifth-grade teacher, Mrs. Arry Susanti. Based on the filling of the validation sheet of lesson plan for meeting 1, 2, 3, and 4, it is obtained $R = 5, R = 5, R = 4{,}75, R = 5$. The average of lesson plan validation is $R = 4{,}93$. In other words, the lesson plan at Pakintelan 1 public elementary school is in the good category. Expert validation of lesson plan at SDN Plalangan 1 is the fifth-grade teacher, Mrs. Siwi. Based on the filling of the validation sheet of lesson plan for meeting 1, 2, 3, and 4, it is obtained $R = 4{,}58, R = 4{,}66, R = 4{,}66, R = 4{,}69$. The average of lesson plan validation is $R = 4{,}81$. In other words, the lesson plan at Plalangan 1 public elementary school is in the good category.

Description of the average value of mathematical game validation, test, discussion sheet (containing problem-posing), test (containing problem-posing) uses category scale as follows.
$0{,}00 \leq R < 0{,}20$: not good (not appropriate, unclear, not efficient, not operational)
$0{,}20 \leq R < 0{,}40$: less good (appropriate, clear, not efficient, not operational)
$0{,}40 \leq R < 0{,}60$: pretty good (appropriate, clear, efficient, less operational)
$0{,}60 \leq R < 0{,}8$: good (appropriate, clear, efficient, operational)
$0{,}80 \leq R \leq 1$: very good (appropriate, clear, efficient, operational and perfect)
Criteria: mathematical game/test/discussion sheet (containing problem-posing), test (containing problem-posing) are said to be valid if the average value of the learning tool validation is in the category at least "good".

Expert validation of mathematical games at Pakintelan 1 public elementary school is the fifth-grade teacher, Mrs. Arry. Based on the filling of the validation sheet for meeting 1, 2, 3, and 4, it is obtained $R = 1, R = 1,\ R = 1, R = 1$. The average of mathematical game validation is $R = 1$. In the other words, mathematical game at Pakintelan 1 public elementary school is in the very good category, while for the test, it is obtained R=1 means that the test is very good used in the research.

Expert validation of the discussion sheet (containing problem-posing) at Plalangan 1 public elementary school is the fifth-grade teacher, Mrs. Siwi. Based on the filling of the validation sheet for meeting 1, 2, 3, and 4, it is obtained $R = 1, R = 1,\ R = 1, R = 1$. The average of discussion sheet validation is $R = 1$. In the other words, the discussion sheet (containing problem-posing) at Plalangan 1 public elementary school is in the very good category, while for the test, it is obtained R=1 means that the test is very good used in the research.

Furthermore, the final draft is tested in the learning in the class. Learning in each class is carried out during 4 meetings and 1 test. The test trial in this class aims to get the data on the practicality and effectiveness of the developed learning tools. Learning tools are said to be practical if they can be used in the setting that has been designed and developed. Instrument used is the observation sheet of learning implementation used to get the about practicality. Indicator to determine the practicality is the average of observation result about learning implementation which is minimal in the good category. The following Table 1 can be used as the criteria for learning implementation in the class.

Table 1. Learning Implementation Evaluation Criteria

Boundary	Evaluation Criteria
$1 \leq P < 2$	Not good
$2 \leq P < 3$	Less good
$3 \leq P < 4$	Good
$P = 4$	Very Good

Note: P = evaluation of the learning process implementation

The average observation result of the learning implementation at Pakintelan 1 in the meeting 1, 2, 3, 4 are 3,45; 3,70; 3,83; and 3,79. After adding up the data, then the average is calculated totally so that obtained the average total value is 3,69. Therefore, the learning tools developed are in the good category. Thus, it can be said that the practicality of the learning tools is fulfilled. This means that the learning tools can be applied in the learning.

The average observation result of the learning implementation at Plalangan 1 in the meeting 1, 2, 3, 4 in a row is 3,375; 3,41; 3,54; and 3,70. After adding up the data, then the average is calculated totally so that obtained the average total value is 3,51. Therefore, the learning tools developed are in the good category. Thus, it can be said that the practicality of the learning tools is fulfilled. This means that the learning tools can be applied in the learning.

The learning tool is said to be effective if the students' thinking abilities of the fifth-grade elementary school reach mastery learning and based on the students' responses questionnaire, more than 50% of the students respond positively to all of the asked aspects. In this study, it involves two elementary schools

with the different mastery learning and stimulus treatment. In this study, a class or group can be said to achieve the mastery learning in the subject matter of solid figure cube and cuboid if more than 75% of the number of students in the class get the minimum learning result of mathematical thinking aspect. The criterium of the minimum mastery learning in this study was adjusted to the research object. The minimum mastery learning criteria of the mathematics subject at Pakintelan 1 is 70. A class or group can be said to achieve mastery learning in the subject matter of solid figure cube and cuboid if at least 75% of the number of students in the class get a minimum grade of 70. The minimum mastery learning criteria of the mathematics subject at Plalangan 1 is 65. A class or group can be said to achieve mastery learning in the subject matter of solid figure cube and cuboid if at least 75% of the number of students in the class get a minimum grade of 65.

The students' mathematical thinking abilities of the fifth grade of Pakintelan 1 that get the TGT learning model with the stimulus of the mathematical game and the use of manipulative teaching aid can achieve the mastery criteria. The students' mathematical thinking abilities of the fifth grade of Plalangan 1 that get the CPS learning model with the stimulus of the problem-posing and the use of manipulative teaching aid can achieve the mastery criteria. The intended mastery test is the mastery of the class average based on the applied minimum mastery criteria and classical mastery so that this mastery test applies if it has reached the class average based on the specified minimum mastery criteria and classical mastery.

This mastery test is used to determine whether the thinking ability of the students achieve the mastery or not. The learning results of the students at Pakintelan 1 are said to be complete if the value of the students can reach the minimum mastery criteria that have been set, which is 70.

Hypothesis :

$H_0: \mu_0 \leq 69{,}5$ (average value of the thinking ability test for the students of the fifth grade Pakintelan 1 public elementary school with TGT learning model with the stimulus of mathematical game, the use of teaching aid is less than or equal to the minimum mastery criteria)

$H_1: \mu_0 > 69{,}5$ (average value of the thinking ability test for the students of the fifth grade Pakintelan 1 public elementary school with TGT learning model with the stimulus of mathematical game, the use of teaching aid is more than the minimum mastery criteria)

The learning results of the students at Plalangan 1 are said to be complete if the value of the students can reach the minimum mastery criteria that have been set, that is 65.

Hypothesis :

$H_0: \mu_0 \leq 64{,}5$ (average value of the thinking ability test for the students of the fifth grade Plalangan 1 public elementary school with CPS learning model with the stimulus of problem posing and the use of teaching aid is less than or equal to the minimum mastery criteria)

$H_1: \mu_0 > 64{,}5$ (average value of the thinking ability test for the students of the fifth grade Plalangan 1 public elementary school with CPS learning model with the stimulus of problem posing and the use of teaching aid is more than the minimum mastery criteria)

Testing is conducted by using statistics of mean test one side that is the right side that the formula according to [35] as follows.

$$t_{\text{calculation}} = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}}$$

Note:

$t_{\text{calculation}}$: student distribution

$\bar{x}$: average of the students thinking ability value

μ_0: average of the minimum mastery learning criteria that is 70

s: standard deviation

n: number of the students

The testing criterium was rejecting H_0 if $t_{\text{calculation}} \geq t_{(1-\alpha)(n-1)}$, for the others, H_0 is accepted with $t_{(1-\alpha)(n-1)}$ is obtained from the standardized normal distribution list with a significance level of 5% and $dk = n - 1$ [35].

To test the classical mastery, it is conducted on the two side proportion test. The two side proportion test is conducted to determine whether the students' thinking abilities of Pakintelan 1 that is more than the minimum mastery criteria achieve more than 75%. To test this hypothesis, it is used the left side proportion test. The statistics hypothesis is as follows.

H_0: $\pi \leq 0{,}745$ (the proportion of the students of the fifth grade Pakintelan 1 public elementary school with the TGT learning model with the stimulus of mathematical game and the use of manipulative teaching aid that is completing the learning is less than or equal to 75%)

H_1: $\pi > 0{,}745$ (the proportion of the students of the fifth grade Pakintelan 1 public elementary school with the TGT learning model with the stimulus of mathematical game and the use of manipulative teaching aid that is completing the learning is more than 75%)

The two side proportion test is conducted to determine whether the students' thinking abilities of Plalangan 1 that is more than the minimum mastery criteria achieve more than 75%. To test this hypothesis, it is used the left side proportion test. The statistics hypothesis is as follows.

H_0: $\pi \leq 0{,}745$ (the proportion of the students of the fifth grade Plalangan 1 public elementary school with the CPS learning model with the stimulus of problem posing and the use of manipulative teaching aid that is completing the learning is less than or equal to 75%)

H_1: $\pi > 0{,}745$ (the proportion of the students of the fifth grade Plalangan 1 public elementary school with the CPS learning model with the stimulus of problem posing and the use of manipulative teaching aid that is completing the learning is more than 75%)

The test uses z statistics with the formula is as follows [35].

$$z = \frac{\frac{x}{n} - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}}$$

Note

z: value $z_{\text{calculation}}$

x: number of the students in the class that get the value ≥ 70

n: number of all students

π_0: the value of the minimum classical mastery that has been determined, π_0 = 75%

The testing criterium was rejecting H_0 if $z_{\text{calculation}} \geq z_{0,5-\alpha}$ where $z_{0,5-\alpha}$ is obtained from the standardized normal distribution list with the probability (0,5-α).

The result analysis of the class average mastery based on the minimum mastery criteria that have been determined at Pakintelan 1 is $t_{\text{calculation}} \geq t_{table}$ where $t_{\text{calculation}} = 5{,}18$, $\alpha = 0{,}05$, and $t_{\text{table}} = 2{,}08$. It means that the average of the test value of the students' thinking ability of the fifth grade Pakintelan 1 with the TGT learning model with stimulus of the mathematical game and the use of manipulative teaching aid is more than the minimum mastery criteria. The result analysis of classical mastery at Pakintelan 1 is $z_{\text{calculation}} \geq z_{\text{table}}$ where $z_{\text{calculation}} = 1{,}72, \alpha = 0{,}05$, and $z_{\text{table}} = 1{,}64$. It means that the proportion of the students of the fifth grade Pakintelan 1 with the TGT learning model with stimulus of the mathematical game and the use of the manipulative teaching aid that is completing the learning in the class is more than 75%. Based on the both mastery tests above, the students' mathematical thinking ability of the fifth grade Pakintelan 1 with the TGT learning model with stimulus of the mathematical game and the use of the manipulative teaching aid can achieve the mastery criteria.

The result analysis of the class average mastery based on the minimum mastery criteria that have been determined at Plalangan 1 is $t_{\text{calculation}} \geq t_{table}$ where $t_{\text{calculation}} = 10{,}19$, $\alpha = 0{,}05$, and $t_{\text{table}} = 2{,}02$. It means that the average of the test value of the students' thinking ability of the fifth grade Plalangan 1 with the CPS learning model with stimulus of the problem-posing and the use of manipulative teaching aid that is more than the minimum mastery criteria. The result analysis of classical

mastery at Plalangan 1 is $z_{\text{calculation}} \geq z_{\text{table}}$ where $z_{\text{calculation}} = 2{,}87, \alpha = 0{,}05$, and $z_{\text{table}} = 1{,}64$. It means that the proportion of the students of the fifth grade Pakintelan 1 with the CPS learning model with stimulus of problem posing and the use of the manipulative teaching aid that is completing the learning in the class is more than 75%. Based on the both mastery tests above, the students' mathematical thinking ability of the fifth grade Plalangan 1 with the CPS learning model with stimulus of problem posing and the use of the manipulative teaching aid can achieve the mastery criteria.

The effectiveness criterium was evaluated from the students' responses to the instrument and learning implementation if at least 50% of the students or more students give an average of positive response on the aspect studied. Students' responses data on the instrument and learning implementation obtained from the questionnaire result is analyzed by calculating the percentage of the number of students who responded in each category asked in the questionnaire sheet to the number of all students who are learning subject, with the formula is as follows.

$$Pr = \frac{\sum Rs}{\sum S} \times 100\%$$

Note:
Pr = percentage of the number of the students who responded in each category asked in the questionnaire
$\sum Rs$ = the number of students who responded in each category asked in the questionnaire
$\sum S$ = the number of all students who are the subject of the trial test of the learning tools.

The students' responses to the thinking stimulus in Pakintelan 1can be seen in Table 2 below.

Table 2. Students' Responses on the Thinking Stimulus at Pakintelan 1 Public Elementary School

Students' responses on the aspect-	% average of each response aspect
Guided questions	96
Mathematical games	90,67
Problem in the game	94,67
The game makes learning mathematics become fun	93
Final test	96

Based on the Table 2 above, it can be analyzed that the students' positive responses on all aspects are above 50%. It means that every aspect is responded positively by the students more than 50%.

The students' responses to the thinking stimulus at Plalangan 1 were presented in Table 3 below.

Table 3. Students' Responses on the Thinking Stimulus at Plalangan 1 Public Elementary School

Students' responses on the aspect-	% average of each response aspect
Guided questions	83
The teacher uses the mathematical teaching aid	93
The teacher asks to make the question of the problem	84
The teacher gives the final test	72
Mathematical learning in the class	82

Based on the Table 3 above, it can be analyzed that the students' positive responses on all aspects are above 50%. It means that every aspect is responded positively by the students more than 50%.

3.2. Discussion

The students' mathematical thinking abilities of the fifth grade Pakintelan 1 public with the TGT learning model with stimulus of the mathematical game and the use of the manipulative teaching aid can achieve the mastery criteria. It means that students can develop their mathematical thinking using games. The research of [36] produces the fact that math games support the reasoning of elementary school students.

Mathematics instruction for elementary school should actively involve students in doing mathematics and have a real goal. Students in elementary school must have opportunities with real experiences to help them construct an understanding of mathematics. According to [37], mathematics instruction for elementary students must meaningfully, purposeful, and interesting. One way to achieve this goal is through play and games. Games can supplement this instruction by providing children with opportunities to practice their early mathematics skills in engaging and meaningful ways [19].

Based on the students' responses table, it is obtained the data that 90,67% of students responded positively towards mathematical games that occurred in the class. The students also give positive responses to the problems presented in the mathematical problem, which is 94,67%. This shows that the mathematical game helps the students are fun to learn mathematics and have an impact on their mathematical thinking abilities. Games as a playful learning situations. the game utilizes intrinsic motivation and has elements that is challenge, control, fantasy, curiosity and interactivity ([38], [39], [40], [41]). Games involve fun, a sense of curiosity and an inhibition of reality, inactive, engaging, meaningful and socially interactive contexts [42]. Playing games is one of the fun learning approach methods integrated into the mathematics curriculum. Game integrated with mathematical content makes the students active and fun learning so that the students become increasingly motivated to learn [43].

The teachers function as a facilitator that helps students curiosity and find answer. In classroom games, the teacher acts as a facilitator who minimizes student play behavior and maximizes learning and enjoyment behavior [44]. The teachers can use games to promote motivation for learning certain content because fun activities constitute the best learning support for the children [45]. In this study, the mathematical game is used as a learning tool. This study recommends future research using mathematical games as a means of assessment, as research by [46]. Well-designed games developed using evidence-centered design (ECD), so it can function as intrinsic motivation and facilitating academic content such as higher-order thinking skills (problem-solving and critical reasoning), ownership of learning, and social skills (communication, collaboration, negotiation, etc) [47].

The students' mathematical thinking abilities of the fifth grade Plalangan 1 public elementary school with the CPS learning model with stimulus of problem posing and the use of the manipulative teaching aid can achieve the mastery criteria. Every aspect studied in the response questionnaire obtains the data more than 50% of students responded positively. Therefore, the mathematical learning tools of the fifth grade integrated the stimulus of problem posing and the manipulative teaching aid was effective. This shows that the teacher can plan problem-posing learning and carry out problem- posing learning and students can solve the problem-posing problem given by the teacher. learning to teach through problem posing, that is, the use of problem-posing tasks to help teachers learn important mathematics content and pedagogical content knowledge and teach through problem posing, meaning the process of helping teachers learn how to use problem posing as a powerful tool for mathematics instruction in their classrooms [31]. Problem-posing activities can have a positive impact on students' learning because problem-posing activities are usually cognitively demanding tasks can promote students' conceptual understanding, foster their ability to reason and communicate mathematically, and capture their interest and curiosity [48].

4. Conclusion

The research results show that the learning tools at Pakintelan 1 and Plalangan 1 public elementary school integrated the stimulus of mathematical games, problem posing, and the use of the manipulative teaching aid are valid, effective, and practical. The recommendation of this study is further research by applying the stimulus of mathematical games, problem posing, and the use of the manipulative teaching

aid to describe the high-level thinking of the elementary school students. Also the use of games as a means for assessment.

References

[1] Nadia L and Pascal B 2016 *Contemp. Educ. Psychol.* 44 41-53
[2] Zvia M and Helen F 2017 *Educ. Stud. Math.* 96 49-64
[3] Deborah A S, Jamie L A, Daniel S and Roy A 2008 *World Cult. eJournal* 16 1-15
[4] Leicha B 2017 *Math. Educ. Res. J.* 19 29-44
[5] Daniel C N 1969 *Arith. Teach* 16 631-40
[6] Darrell F and Tony R 1998 *Math. Educ. Res. J.* 10 3-15
[7] Zülbiye T U, Mutlu P, Elif N A and Dijle T 2010 *Educ. Sci.* 35 131-44
[8] Jo B 2014 *Teach. Child. Math.* 20 469-74
[9] Mansureh K, Atsusi H and Haiyan B 2010 *Comput. Educ.* 55 427-43
[10] Brian B 2005 *J. Child Psychol. Psychiatry* 46 3-18
[11] Amy C, Greg D and Mimi E 2009 *Econ. Educ. Rev.* 28 415-27
[12] Greg J D, Chantelle J D, Amy C, Katherine M, Aletha C H, Pamela K, Linda S P, Leon F, Mimi E, Jeanne B G, Holly S, Kathryn D and Crista J 2007 *Dev. Psychol.* 1428-46
[13] Sandra M L Julie B S and Jennifer C 2015 *Sch. Sci. Math.* 115 392-403
[14] Kyli W and Lesh P M 2019 *Netw.: Online J. Teach. Res* 21 1-19
[15] Fred J J M J, Hanna B W and Jan H V D 2014 *Instr. Sci.* 42 67-90
[16] Michael F Y, Stephen S, Andrew BC, Gerard J, Greg M, Benedict L, Zeus S, Mattew T and Mariya Y 2012 *Rev. Educ. Res.* 82 61-89
[17] Marc I C 2015 *Interdiscip. J. Probl.-Based Learn.* 9 1-18
[18] [18] Jacob H and Shaaron E A 2011 *J. Learn. Sci.* 20 169-206
[19] Geetha B R, Emily N D and Nicole R S 2019 Role of Play and Games in Building Children ' s Foundational Numerical Knowledge *Cognitive Foundations for Improving Mathematical Learning* Vol 5, ed D Geary, D Berch and K M Koepke (Elsevier) chapter 3 pp 69-90
[20] Stamatios P, Michail K and Nicholas Z 2017 *Early Child. Educ J* 45 369–78
[21] Kerstin L, Paul A and Inger R 2019 Mathematical Games can make a Difference: An Intervention for Children at Risk *Proc. Int. Symp. Elem. Math. Teach.* ed *J Novotná and H Moraová* (Prague: Charles University) p 243 .
[22] Zhi-Hong C, Calvin C Y L, Hercy N H C, Charles Y C Y and Tak-Wai C 2012 *J. Educ. Technol. Soc.* 15 317-27
[23] Peter W A and Mary E W 1997 Phi Delta Kappan 78 444-49
[24] Christopher P B, Craig A A and Edward L S 2009 *Simul. Gaming* 40 377-403
[25] Douglas W, Yuxin M, Steven F, Charles E R and Louise P 2007 *Br. J. Educ. Technol.* 38 429-37
[26] Kristian K 2007 *Br. J. Educ. Technol.* 38 394-404
[27] Jesper J 2005 *Half-real. Video games between real rules and fictional worlds* (Cambridge, MA: The MIT Press)
[28] Jesse S 2008 *The Art of Game Design* (Burlington: Morgan Kaufmann Publishers) chapter 3 p 37
[29] Gener S S, Jennifer L A, Jeff C A, Jacinto Y B and Irene C D 2019 *Open Access Libr. J. 6 1-7*
[30] Yeap B H and Berinderjeet K 1997 *Teach. Learn. 18 64-72*Jinfa C and Stephen H 2019 International Journal of Educational Researchpp 0-1
[31] Nerida F E 1986 *Educ. Stud. Math.* vol 17 pp 261–71
[32] Niamh O, Patrick J and Aisling L 2019 *Int. J. Geogr. Inf. Sci.* pp 1-23
[33] Sivasailam T, Dorothy S S and Melvyn I S 1974 *Instructional development for training teachers of exceptional children: A sourcebook (Bloomintom: Indiana University)* chapter 1 pp 5-11
[34] Nana S 2005 Dasar-dasar Proses Belajar Mengajar (Bandung: Sinar Baru Algensindo)
[35] Janelle M P and Kylie P 2018 *J. Math. Behav.* pp. 103-25
[36] Arthur J B and Janice H 1991 *Remedial Spec. Educ.* 12 54-68

[37] Leonard A A 2010 *Rev. Gen. Psychol.* 14 105-12
[38] Fran C B, Debby E A, Jared S A and Naoko H 2013 *The Oxford handbook of media psychology* chapter 19 pp 334–51
[39] [Marc P 2001 *Digit. game-based learn.*pp 5-31
[40] Peter M 2014 *International Conference on e-Learning* Academic Conferences International Limited p 272
[41] Brenna H D, Tamara S T, Jennifer M Z, Jessica M, Roberta G and Kathy H P 2017 *J. Study Educ. Dev.* pp 1-28
[42] Jennifer M Z, Brenna H D, Tamara S T, Kathy H P and Roberta G 2016 *J. Mathe Matics Educ. Teach. Coll* 7 45-9
[43] Saeideh H, Nicole K and Taliesin S 2017 *Int. J. Sci. Math. Educ.* 16 777-96
[44] Helena C and Rute M 2016 *Int. J. Math. Educ. Sci. Technol.* 57 463-74
[45] Meg G and Chase N 2018 *J. Res. Technol. Educ.* 50 134-48
[46] Valerie J S and Fengfeng K 2012 *Assessment in game-based learning* (Springer: New York) chapter 4 pp 43-58
[47] Jinfa C, Ting C, Xinlian L, Ranran X, Shasha Z, Yuanyan H, Ling Z and Naiqing S 2019 *Int. J. Educ. Res.*