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Developing Metacognition Assessment Instrument in Solving Word Problem of Cube and Cuboid for Primary School

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Abstract: Developing Metacognition Assessmen Instrument in Solving Word Problem of Cube and Cuboid for Primary School*.One of the objectives in mathematics learning is problem solving. Concerning problem solving, metacognition is a method to improve problem solving skill. However, a number of teachers were unable to assess using metacognition in order to improve problem solving. Therefore, this research aimed to create a metacognition assessment instruments in solving cube and cuboid word problems, which could help both teachers and students assess their metacognition knowledge and hence experience problem solvig skill improvement. This was a five-phase Plomp model of development research which started by initial investigation phase, design phase, realization phase, test, evaluation and revision phase, and implementation phase. Interviews, questionnaire and documentation were instruments of data collection. Subjects were 2 mathematic lecturers and a linguistic lecturer for expert validation test, 3 Grade V Citra Bangsa Christian Elementary School teachers for practicality test, and 70 Grade V students of Citra Bangsa Christian Elementary School Grade for limited try out. This research produced a metacognition instrument of assessment to solve problems in form of cube and cuboid word problem that had been examined and evaluated by expert validators. The average score given by the validators was > 4.2 which was categorized as very good. Subsequently, average score of practicality test ran by three teachers reached > 4.2 which was categorized as strongly agree with the instrument's production meanwhile the reliability test coefficient was 0.645. Thus, the instrument of metacognition assessment was valid, practical, and reliable.*

Keywords*: Instrument, metacognition comprehension, problem solving.*

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I. Introduction

Permendiknas Number 22 Year 2006 states 5 objectives of mathematics in which one of them is problem solving. Problem solving is a procedure to undertake in solving problems. NCTM (2000) proposed that problem solving is the main focus of mathematic learning.

When it comes to metacognition, Suherman, *et.al* (in Bulu, 2015: 971) suggested that one's ability to solve problems depends on his/her awareness of prior knowledge and how to apply it. Flavel (1979) stated that this awareness is named as metacognition or "thinking about thinking."

In addition, Ozsoya dan Ataman (2009:70) perceived that metacognition plays important role in problem solving. Similarly, other studies presented the relationship between metacognition with mathematics problems solving and the role of metacognition in increasing mathematic problem solving skill. Studies conducted by Danoebroto (2008) and Ozsoya and Ataman (2009) reported that students who learned mathematic through PMRI approach and metacognitive training performed better than students in conventional approach class.

A number of studies showed that the use of metacognition assessment instrument highly helped teachers to recognize students' metacognitive competence in solving problems. Ozcan (2014) reported in his study that the use of offline metacognition instrument of assessment was effective to identify students' metacognition ability. Similar result was found by Yildiz, *et.al* (2009) that the use of metacognition instrument of assessment helped teachers to identify students' metacognition competence easier.

Based on observation and interview toward teachers and Grade V students of Citra Bangsa Christian Elementary School (SDK Citra Bangsa) concerning mathematic learning, students had low comprehension on problem solving test in cube and cuboid word problem of geometry. It could be seen from learning process and result on cube and cuboid of geometry during even semester in Grade V. It appeared in learning process aspect that when the students were given regular test and non-regular test (story test item), students' mastery on regular test was higher than non-regular test. It directly resulted in students' low problem solving skill. This was an

issue to be noticed and solved. At the same time, teachers' understanding about metacognition as a way to improve problem solving skill was low.

Consequently, it was expected that the instrument development of metacognition assessment could help teachers and students to previously examine the mapping of Citra Bangsa Christian Elementary School students' metacognition competence and utilize it as guideline in improving their metacognition to solve mathematic problems about cube and cuboid of geometry in form of word problem.

II. Method

This was a development research using Plomp model adjusted to fit the needs of this research. It was classified into five phase which were (1) initial observation phase, (2) design phase, (3) realization phase, (4) test, evaluation, and revision phase, and (5) implementation phase. This study was conducted during even semester of 2018/2019 academic year in Grade V of Citra Bangsa Christian Elementary School, Kupang City.

Subjects of this research product trial consisted of expert validation test on assessment instrument, limited group test by students, and practical test by teachers. Expert test on instrument was done by two mathematic lecturers of Nusa Cendana University and Widya Mandira Catholic University and a linguistic lecturer from Citra Bangsa University, Kupang. Then, limited test was administered to 70 students in VA, VB, and VC class of Citra Bangsa Christian Elementary School whereas practical test was done to mathematics teachers of the three classes. These three tests and a realiability test were carried out as an effort to retrieve feedbacks from the experts, classroom teacher to examine instrument's appropriateness to be implemented toward Grade V students or students in other schools. Data of this study was gathered through interview, observation and test using interview guideline, expert validation test and practical test questionnaire as instruments.

III. Result And Discussion

This research applied Plomp model of development research which was adjusted with the needs this study. This model comprised five development phases among which (1) initial observation phase, (2) design phase, (3) realization phase, (4) test, evaluation, and revision phase, and (5) implementation phase. In initial observation phase, Grade V teachers were interviewed and lesson plans were analyzed to analyze fundamental problems occurred in Grade V of Citra Bangsa Christian Elementary School. It was revealed that Grade V teachers never designed metacognition instrument of assessment since they had unclear information regarding the objective of this assessment. Besides, they had no insight of assessment instrument design to solve problems in form of word problems. Teachers also suggested topic on cubes and cuboids of geometry since they observed that these subtopics were quite difficult for their students. Hence, they suggested the instrument was designed to solve problems in these subtopics. The point was also supported by a finding in lesson plan in which there was no assessment instrument of students metacognition in problem solving attached to assessment sheet though the material directly related to cube and cuboid of geometry. It was also strengthened by Ozcan (2014) which discoved in his study that the use of offline assessment instrument of metacognition was effective to recognize students' metacognition ability. Similar idea was also presented by Wisnanti, *et.al* (2014), Purwanti (2016) and Nasir, *et.al* (2018) that the availability of instrument for metacognition assessment helped teacher and students to identify students' metacognition knowledge so they could offer solution in increasing students' competence to solve mathematics problems.

The next stage was design phase to design instrument cover, indicators of metacognition competence, mathematics problem in form of story item test about cubes and cuboids, questions related to conceptual knowledge, procedural and conditional, and description of assessment criteri as well. It was continued to realization phase as a continuum of previous stage to idealize the instrument. Then, it was proceded to test, evaluation, and revision phase by running validity test, practicality test, and reliability test. The researcher gained plenty feedbacks aas presented in table below.

Table 1: Expert Validator Revision toward Assessment Instrument of Metacognition Competence

No	Before Revision	After Revision
1.	No additional detail about material addition. 1.1. A cube shaped bath tube has 1 m edge length. Its 4/5 part had been filled. How many litres of water are needed to make it full? (***Researcher***) 1.2. A cuboid-shaped bath tube in Jemi's house is 90 cm height, 160 cm face length and 80 cm width. It has been 2/3 filled. To make it, Jemi has to add ... litres. (***Validator 1***)	Adding detail about material addition. The question becomes: 1.1. A cube shaped bath tube has 1 m edge length. Its 4/5 part had been filled with **water**. How many litres of water are needed to make it full? (***Researcher***) 1.2. A cuboid-shaped bath tube in Jemi's house was 90 cm height, 160 cm length, and 80 cm width. **Water** has filled its 2/3 parts. To make it

		full, Jemi has to add ... litres of **water**. (***Researcher)***
2.	Font size in instrument is not consistent. Instrument objective was written using font size 14 of *Times New Roman*, whereas problems and questions used similar font type with font size 12. (***Validator 2***)	Revising font size into 12 for all parts of instrument. (***Researcher)***
3.	Make appealing cover to attract students' attention when they are working on test items in instrument. (***Validator 3***)	Modifying cover into appealing one as shown in appendice (***Researcher***)

The instrument was revised based on expert validator's valuable input to polish it up. Instrument filling result was then analyzed descriptively and the three validators gained >4.2 average score or in very good category. It indicated that this instrument was appropriate to be used in assessing students' metacognition competence in solving cubes and cuboids test items. The instrument also applied practicality test undergone by 3 mathematics teachers of Grade V. They also provided revisions as pictured in the following table.

Table 2: Mathematics Teacher Revision on Assessment Instrument of Metacognition Competence

No	Before Revision	After Revision
1.	Test item number 1.6 and 2.6 had no separation between informstion and strategy to make assessment easier in accordance with assessment criteria. The instruction was as followed. 1.6. Answer the question using appropriate information and strategy to solve story test of cube problem! ***(Procedural Competence)*** 2.6. Answer the question using appropriate information and strategy to solve story test of cuboid problem! ***(Procedural Competence)*** ***(Mathematic teacher of VA class)***	Separate information and strategy of test item number 1.6 and 2.6 as shown below: 1.6. Answer the question using appropriate information to solve story test of cube problem! ***(Procedural Competence)*** 1.7. Answer the question using appropriate strategy to solve story test of cube problem! ***(Procedural Competence)*** As for cuboid test item, 2.6. Answer the question using appropriate information to solve story test of cuboid problem! (***Procedural Competence***) 1.1. Answer the question using appropriate strategy to solve story test of cuboid problem! (***Procedural Competence***) ***(Researcher)***
3.	Assessment cover design did not look appealing for Grade V level, so a more attractive cover must be designed. ***(Mathematic teacher of VB class)***	Cover design was revised. ***(Researcher)***

The practicality test gained > 4.2 average score and was categorized as strongly agree. This result implied that teachers indeed agreed upon the metacognition assessment instrument in solving story test item. Reliability test was done in SPSS 16.0 and scored 0.645 point. It was higher than 0.60 which meant tat the instrument was reliable and applicable in different situation and condition.

After passing these three tests, a conclusion could be drawn that this instrument was appropriate, practical, and applicable in different condition and situation. Eventually, it was applied in implementation phase through limited try out toward 70 students in VA, VB, and VC class to get students' classification based on metacognitive level. An analysis result on 19 VA students worksheet displayed students in medium cognition level and low level students. Below are the instrument and assessment criteria of assessment instrument.

Table 3: Assessment Instrument of Metacognition in solving story test item of Cube and Cuboid

Problem 1: A cube-shaped bath tube has 1 m edge length. Its 4/5 part had been filled with water. How many litres of water are needed to make it full?	*Problem 2:* A cuboid-shaped pool was initially filled with 2500 litres of water. It was drained up and water volume was 2/5 part of previous. How many centimeters of water height are remained if the width of pond base is $10m^2$!
1.1. To solve the problem, mention steps you need to take to solve the problem? (***Declarative knowledge***)	1.1. To solve the problem, mention steps you need to take to solve the problem? (***Declarative knowledge***)
1.2. In point 1, what information does the problem have? (***Declarative knowledge***)	1.2. In point 1, what information does the problem have? ***Declarative knowledge***)
1.3. After reading information in problem 1, write down information you know using mathematics symbols?	1.3. After reading information in problem 1, write down information you know using

(***Declarative knowledge***)	mathematics symbols? (***Declarative knowledge***)
1.4. Explain concepts related to problem 1 which is applicable to solve it! (***Declarative knowledge***)	1.4. Explain concepts related to problem 1 which is applicable to solve it! (***Declarative knowledge***)
1.5. Mention appropriate strategies to solve problem 1! (***Declarative knowledge***)	1.5. Mention appropriate strategies to solve problem 1! (***Declarative knowledge***)
1.6. Work on the question using appropriate information to solve cube story test! ***(Procedural knowledge)***	1.6. Work on the question using appropriate information to solve cuboid story test! ***(Procedural knowledge)***
1.7. Work on the question using appropriate strategy to solve cube story test! ***(Procedural knowledge)***	1.7. Work on the question using appropriate strategy to solve cuboid story test! ***(Procedural knowledge)***
1.8. Has this strategy been used to solve problems you found before? If yes, explain! ***(Conditional knowledge)***	1.8. Has this strategy been used to solve problems you found before? If yes, explain! ***(Conditional knowledge)***
1.9. Explain your reason of using the chosen strategy! ***(Conditional knowledge)***	1.9. Explain your reason of using the chosen strategy! ***(Conditional knowledge)***
1.10. Is there another applicable strategy to solve the problem? If yes, mention and explain solution to problem 1 using the strategy! ***(Conditional knowledge)***	1.10. Is there another applicable strategy to solve the problem? If yes, mention and explain solution to problem 1 using the strategy! ***(Conditional knowledge)***

Eventually, assessment criteria description in assessment instrument of metacognition to solve story test items on cube and cuboid was presented in table 4.

Table 4. Assessment Criteria Description of Metacognition

Metacognition Type	Indicators	Measured Aspects	Score
Declarative Knowledge	1. Knowledge on steps needed to solve given problems.	Identify steps correctly	3
		Identify steps correctly but incomplete	2
		Identify less complete and correct steps.	1
		Unable to identify steps used to solve problems/ Do not work at all	0
	2. Knowledge on crucial information to solve cube and cuboid story test items.	Identify correct and complete information.	3
		Identify information correctly but incomplete.	2
		Identify less correct and complete information.	1
		Unable to identify information from story test item/ Do not work at all	0
	3. Ability to understand symbols.	Write information in mathematics symbol correctly and completely	3
		Write information in mathematicssymbols correctly but incomplete.	2
		Write information in less correct and complete mathematic symbols.	1
		Unable to write information in mathematic symbol/ Do not work at all	0
	4. Knowledge on concepts related to and that are applicable to solve cube and cuboid story test items	Identify concepts related to problem correctly and completely.	3
		Identify concepts related to problem correctly but incomplete.	2
		Identify less correct and complete concepts related to problem.	1
		Unable to identify concepts related to problem/ Do not work at all.	0
	5. Knowledge on applied strategy.	Write down applied strategy correctly and completely	3
		Write down applied strategy correctly but incomplete.	2
		Write down less correct and complete applied strategy	1
		Unable to write down applied strategy / Do not work at all.	0
Procedural Knowledge	6. Making use available information to solve cube and cuboid story test items	Use correct and complete available information to solve problem.	3
		Use correct but incomplete available information to solve problem.	2
		Use incorrect and incomplete available information to solve problem.	1

		Unable to use available information / Do not work at all.	0
	7. Making use available strategy to solve cube and cuboid story test items.	Use correct and complete available strategy to solve problem.	3
		Use correct but incomplete available strategy to solve problem.	2
		Use incorrect and incomplete available strategy to solve problem	1
		Unable to use available strategy to solve problem / Do not work at all.	0
Conditional Knowledge	8. Using previously learned and helpful strategy to solve cube and cuboid story test items.	Identify correct and complete previously learned and helpful strategy to solve cube and cuboid story test items.	3
		Identify correct but incomplete previously learned and helpful strategy to solve cube and cuboid story test items.	2
		Identify incorrect and incomplete previously learned and helpful strategy to solve cube and cuboid story test items.	1
		Unable to identify correct and complete previously learned and helpful strategy to solve cube and cuboid story test items/ Do not work at all.	0
	9. Reason of using selected strategy.	Write down correct and complete reason of using selected strategy.	3
		Write down correct but incomplete reason of using selected strategy.	2
		Write down incorrect and incomplete reason of using selected strategy.	1
		Unable to write down reason of using selected strategy/ Do not work at all.	0
	10. Using another strategy in answering cube and cuboid story test item	Use another correct and complete strategy in answering cube and cuboid story test item.	3
		Use another correct but incomplete strategy in answering cube and cuboid story test item.	2
		Use another less correct and complete strategy in answering cube and cuboid story test item.	1
		Unable to use another correct and complete strategy in answering cube and cuboid story test item/ Do not work at all.	0

IV. Conclusion

The conclusion drawn of this study on developing assessment instrument of metacognition to solve cube and cuboid story test item were:

1. The procedure of developing assessment instrument of metacognition used development model by referring to Plomp model which was adjusted to the needs of this research. This model consisted of five developmental stages, namely (1) initial observation phase, (2) design phase, (3) realization phase, (4) test, evaluation, and revision phase, and (5) implementation phase. The first phase begun by interviewing Grade V teachers of Citra Bangsa Christian Elementary School to recognize assessmet model used to assess metacognition and material teachers advised as substance in designing assessment instrument. The information was supported by document analysis on lesson plan in which metacognition assessment was not apllied though the material directly related to solving mathematic problem. The second phase was designing assessment instrument cover, metacognition indicators, mathematic problems in form of cube and cuboid story test items, questions related to conceptual, procedural, and conditional knowledge as well as assessment criteria. The third phase functioned to perfecting the assessment instrument. Then, the instrument went through expert validation, practicality test, and reliability test in fourth phase simultaneously with its evaluation. Both expert validation and teacher response in practicality test gained average score categorized in very good and strongly agree category. Feedbacks from experts and teachers were used by the researcher to revise the instrument. The revised instrument was finally used in limited test toward 70 students in VA, VB, and VC class in which their metacognition ranged from low to medium level.
2. The result developing assessment instrument of metacognition in solving cube and cuboid story test item was confirmed valid, reliable, and practical hence it can be used by Grade V teacher and students of Citra Bangsa Christian Elementary School to assess and map students' metacognition in solving cube and cuboid story test item.

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