International Journal of Trends in Mathematics Education Research
Vol. 2, No. 3, Juni 2019, pp. 120-123
Available online at http://ijtmer.com

E-ISSN : 2621-8488

RESEARCH ARTICLE

Development Learning Design Based on Metacognitive Strategies Oriented to Critical Thinking Skill

Madya Hutabarat[1*], Caswita[2], Suharsono[3]

[1,2]Department of Mathematic Education, University of Lampung, Lampung, Indonesia. 35145
[3]Department of Mathematic, University of Lampung, Lampung, Indonesia. 35145
*Corresponding author email: madyamagister@gmail.com

How to Cite: Hutabarat, M.,Caswita, & Suharsono. (2019). Development Learning Design Based on Metacognitive Strategies Oriented to Critical Thinking Skill. *International Journal of Trends in Mathematics Education Research, 2*(3), 120-123.

ARTICLE HISTORY

Received: 12 February 2019
Revised: 18 March 2019
Accepted: 28 April 2019

KEYWORDS

Learning Design;
Metacognitive strategies;
Critical thinking skill;

ABSTRACT

The purpose of this study is to develop a mathematical learning design based on metacognitive strategies that are oriented to critical thinking skills that are valid, practical and effective in solid geometry. The research was carried out with stages in Nieveen's model that begins with preliminary research, prototyping stage, and assessment stage. The field test design uses the pretest-posttest control group design. Data collection used a validation sheet, student and teacher questionnaire responses, and test instruments of critical thinking skills. Respectively to determine the validity of learning design, the level of practicality, and the effectivity of learning design. Validity and practicality were analyzed by using deskiptif statistics, while effectivity were analyzed by Mann Whitney U. Classical completeness, critical thinking skills, and improving critical thinking skills of students who apply learning based on metacognitive strategies are better than conventional learning. Therefore the design of learning based on metacognitive strategies is feasible because it meets the criteria of valid, practical and effective to improve students' critical thinking skills.

1. INTRODUCTION.

The development of education is very influential on the progress of a country. Education is the main factor that needs to be prepared to improve potential and quality human resources. One aspect of education that plays an important role in producing quality human resources is mathematics education. Mathematics subjects need to be given to all students starting from elementary school to equip students with the ability to think logically, analytically, systematically, critically, and creatively, and the ability to work together. The field of mathematics studies is an important part in an effort to improve critical thinking skills.

Students' critical thinking skills are very important to have and develop, so that students are able to identify, analyze and solve problems creatively, and be able to think logically to produce appropriate considerations and decisions (Tinio, 2003). Critical thinking skills cannot develop by themselves along with human physical development, these skills must be trained through the provision of stimulus that requires someone to think critically by involving students actively in the learning process. Schools as institutions that provide education have the responsibility to help students develop critical thinking skills.

The ability of Indonesian students at the international level can be seen from the results of the PISA study (Program for International Student Assessment). The table below shows data from PISA in three survey.

Table 1. Average Indonesian Mathematics Scores in the 2009-2015 PISA

Year	Average	Ranking	Number of countries
2009	371	61	65
2012	375	64	65
2015	386	64	72

Table 1 shows that the average score of Indonesian students is far below the OECD average of 490. At the national level, the ability of Indonesian students can be seen in Table 2, namely the average score of National Examination in SMP Negeri 18 Bandar Lampung in 2015-2017.

Table 2. Average Mathematics National Examination Value of SMP Negeri 18 Bandar Lampung in 2015-2017

Year	Average Score
2015	54,24
2016	53,65
2017	66,23

Table 2 shows that the average UN score is not satisfactory. Basically the components tested in the UN are the same as those tested on PISA, namely: numbers, data, algebra and geometry.

Based on interviews with mathematics teachers at SMP Negeri 18 Bandar Lampung related to the results of the Mid Semester Exam and the habits of students in the class, it is known that 58% of students have not been able to reach the Minimum Criteria. The results of interviews and observations at the time of mathematics

learning the learning methods used were less varied, the learning methods commonly used by teachers were conventional learning methods. Learning begins with an opening greeting then the teacher directly explains the material and gives an example of the problem and its solution. Conventional learning is teacher centered so that students passively accept lessons, students are reluctant to answer questions from teachers and lack confidence in asking questions/ideas/ideas, students have difficulty understanding the intent and purpose of the problem, students have difficulty identifying concepts in the problem, some have not been able write strategies correctly, students have difficulty evaluating questions that have been solved, and students have difficulty making conclusions from the material that has been studied. If the ability to analyze questions is still low, critical thinking skills are also low. Because students who have the ability to think critically are able to analyze the problem by writing the right resolution strategy.

This shows that students' critical thinking skills need to be developed because the characteristics of learning used by teachers so far have not facilitated students to develop their critical thinking skills. Realizing the importance of a learning strategy to develop students' critical thinking skills, it is necessary to design mathematical learning that involves students more actively in the learning process.

Mathematics learning 2013 curriculum adds a component of metacognition. This decision shows that education in Indonesia has realized the importance of the ability of metacognition to be trained to obtain optimal learning outcomes. mathematics learning must be able to involve the process and active thinking of students by developing metacognitive behaviors. This is supported by the Curriculum Development and Planning Section of the Singapore Ministry of Education. Lessani (2014) states that metacognitive is an important skill that is very necessary in learning mathematics, so students can monitor and control the way of thinking.

Various studies have shown the positive impact of metacognitive learning strategies. Among them showed an increase in student learning outcomes and an increase in critical thinking skills (Camahalan in Toit, 2009; Gama, 2004; Anggo, 2011; 2015; and Magno, 2010). Metacognition factors positively correlate with critical thinking. Thus, efforts to involve metacognition in various learning activities can provide benefits in the process of improving the quality and results of learning, especially students' critical thinking skills.

This is supported by the opinion of Schoen (Magno, 2010). Students' critical thinking skills can be developed and facilitated through metacognition. Because in metacognition there is the ability to control one's knowledge and thinking (metacognitive control) and this process directs someone to think critically. Furthermore Brown (Magno, 2010) states that critical thinking is impossible to achieve without metacognition. This is because to develop critical thinking skills a higher level of cognitive ability is needed than just information processing. On the contrary students who do not apply their metacognitive skills are less aware of what they are doing when doing Wagner and Stenberg's tasks (Hartman, 1984). For example what information is in the textbook, what should be done and how long it takes to solve a problem.

Based on the description of the background of the problem above, the research problem is focused on the effectiveness of mathematical learning design based on metacognitive strategies. The purpose of the research is to produce mathematical learning designs based on metacognitive strategies that are valid, practical and effective to improve students' critical thinking skills.

2. RESEARCH METHOD

This research is a development research that uses the model Nieveen (2006). Nieveen's model stages in developing learning designs based on metacognitive strategies, namely.

1. Preliminary research

This study begins with observing the ongoing learning process of mathematics in the classroom, then continues with interviews with subject teachers to identify prolems that occur in the field and to identify student activities during the learning process.

2. Prototyping stage

Based on the results of observations and interviews analyzed the needs of students in the learning process, then designed learning design to overcome the problems that occur.

(1) Product Design

Learning design based on metacognitive strategies in the material of building flat-side space was developed with ASSURE learning design theory.

a) *Analyze Learners*
The results of the characteristic analysis obtained data that students have heterogeneous abilities and diverse learning styles.

b) *State Objectives*
Formulating learning objectives for building flat-side space adapted to core competencies and basic competencies in the 2013 curriculum.

c) *Select Instructional Methods, Media, and Materials*
To activate the students used the method of discussion and question and answer.

d) *Utilize Media and Material*
The solid geometry is equipped with learning material such as cubes, cuboids, prisms and pyramid.

e) *Require Learner Participation*
Encourage student participation with group discussions.

f) *Evaluate and Revise*
Assessing the effectiveness of learning.

(2) Evaluation and Revision

After the design of the learning and the device is developed, then the validity and practicality are analyzed. The validity analysis of learning design and devices was obtained from validation sheet data filled by experts and analysis of the practicality of learning design seen from the questionnaire responses of students and teachers. The total score obtained from each instrument was analyzed by conversion using a formula.

$$P = \frac{x_i - x_{min}}{x_{max} - x_{min}} x\ 100\%$$

Then interpreted using the score conversion table (Arikunto, 2009) as follows.

Table 3. Practicality and Validity Level

(P)	Validity Criteria	Practical Criteria
80-100	Very Valid	Very Practical
66-79	Valid	Practical
56-65	Sufficient	Sufficient
40-55	Less	Less
0-39	Very Few	Very Few

3. Assessment Stage

Design product that has been declared valid and practical is followed by a field test to determine the effectiveness of the product being developed. The field test design used was the pretest-posttest control group design proposed by Wallen and Fraenkel (1993: 248).

Effective learning is viewed from the learning objectives, namely the achievement of good learning outcomes. In this study learning outcomes were measured by a critical thinking ability test instrument. The following are indicators of learning design effectiveness, (1) classical completeness of more than 75%, meaning that at least 75% of students in class reach 70 (2) critical thinking skills of students who use learning design based on metacognitive strategies better than critical thinking skills of students who use learning conventionally, (3) N-Gain scores of students who use learning design based on metacognitive strategies are better than students' N-Gain scores using conventional learning.

The field test sample was selected by random sampling technique and obtained class VIII H as the experimental class and class VIII F as the control class. The experimental class was taught using learning design based on metacognitive strategies while the control class was taught using conventional learning.

The instruments used to collect data in this study include validation sheets, practicality questionnaires, and tests of critical thinking skills. Before use the instrument is validated based on content validity by experts who are competent in their field to obtain a valid instrument.

The indicator of the critical thinking skill test developed (1) interpretation, namely understanding the problem indicated by writing the known and asking by questions correctly. (2) analysis, which is identifying the relationships between statements, questions, and concepts given in the questions indicated by making mathematical models correctly and giving precise explanations. (3) evaluation, namely using the right strategy in solving problems, complete and correct in carrying out calculations. (4) inference, which is making conclusions appropriately.

The critical thinking test instrument was also empirically validated which was tested to determine the level of validity, reliability, level of difficulty, and differentiation of each item in question. The instrument of critical thinking ability test is used after it is declared valid, reliable, has a moderate level of difficulty, and has a good distinguishing power.

3. RESULT AND DISCUSSION

The process of developing the learning design carried out refers to Nieveen's model. Which consists of the preliminary stage, prototyping stage, and assessment stage. From the preliminary study, data was obtained that the teacher still used conventional learning methods in mathematics learning. While students look passive listening to the explanation from the teacher. This causes the habits of students during mathematics learning, namely (1) students are reluctant to answer questions from the teacher and lack confidence in asking questions / ideas / ideas so that the teacher does not know whether students have understood the explanation from the teacher or not, (2) students have difficulty understanding the intent and purpose of the question, (3) students have difficulty identifying the concepts on the question, (4) students have difficulty evaluating the questions that have been solved, and (5) students have difficulty making conclusions from the material that has been studied.

This shows that the learning characteristics used by teachers so far have not facilitated students to develop their critical thinking skills. Based on the needs analysis, it is necessary to develop a learning design that fits the characteristics of students to improve their critical thinking skills. The design developed consists of syntax, social systems, support systems, and instructional and accompaniment impacts.

The next stage is conducting validation by learning design development experts, material experts and media experts by including the assessment sheet. The following is the recapitulation of validation by the validator.

Table 4. Results of Validation of Learning Designs and Devices

Component	P	Criteria
Learning Designs	75	Valid
Syllabus	80	Very Valid
Lesson Plan	83	Very Valid
Worksheet	83	Very Valid
Test Instrument	82	Very Valid

The following is a recapitulation of the assessment of learning design components.

Table 5. Results of Validation of Learning Design Component

Component	P	Criteria
Supporting theory	67	Valid
Structure of development of Metacognitive design	76	Valid
Desired learning outcomes	83	Very Valid

Obtaining a validation score by experts is interpreted using a validity table and product revision table adapted from the score conversion table Arikunto (2009) and obtained a valid assessment category. Suggestions and input from the validator are used as considerations to make the first revision with the aim of perfecting the initial product.

After being declared valid by the expert, then it was tested on the initial field to find out the responses from the mathematics teacher and students who were studying the material on the flat side space outside the research class regarding the practicality of the learning design developed. Tests of learning design based on metacognitive strategies were carried out in class VIII G, namely classes that had never applied learning design based on metacognitive strategies.

The following categories of teacher responses to learning design based on metacognitive strategies.

Table 6 Category of Teacher Responses to Learning Design

Component	P	Criteria
Clarity of instructions for using lesson pln	75	Practical
Achievement of competencies and learning objectives	67	Practical
Response of students	78	Practical
The level of difficulty in implementing it	87	Very Practical

The following are categories of assessment of student responses to the design of mathematics learning based on metacognitive strategies.

Table 7. Category of Student Responses to Learning Design

Component	P	Criteria
Preface	79	Practical
Core	78	Practical
Closure	78	Practical

Based on results of analysis of teacher and student responses, it can be concluded that mathematical learning design is based on practical metacognitive strategies and can be used in the field. Furthermore, the assessment stage, namely field testing by applying learning design based on metacognitive strategies in the experimental class and conventional learning in the control class to determine the effectiveness of learning design.

Analysis of critical thinking skills was obtained from the results of posttest given after learning.

Table 8. Analysis of Students' Critical Thinking Skill After Learning

Component	Eksperimen	Kontrol
Mean	80,65	70,65
Median	84	70
Standar Deviation	10,71	6,93
Completeness (%)	84	70
N-Gain	0,71	0,56

Analysis of the critical thinking skill after learning is done using the non-parametric statistical test, with a significance level of 0.05. This test is done because the data does not meet the normal assumptions. The data obtained are, (1) One Sample Kolmogorov Smirnov test results obtained by the Sig. amounting to 0.018: 2 which is 0.009 <0.05. This means that the critical thinking skills of students who apply learning design are more than 70, and classical completeness is 84% (2) The results of the Mann Whitney U test of students' critical thinking skills are obtained by the Sig. that is equal to 0,000 <0,05. Which means that critical thinking skills of students who apply metacognitive-based learning design are better than the critical thinking skills of students who apply conventional learning. (3) The results of the Mann Whitney U N-Gain score obtained the Sig. that is equal to 0,000 <0,05 this shows that the improvement of critical thinking skills of students who apply learning design based on metacognitive strategies is better than students who apply conventional learning.

The conclusion of this study is that effectiveness is caused by several factors, including the first factor is the formulation of a metacognitive strategy in the design of learning developed. Permendikbud No. 103 of 2014 Article 2 paragraph 4 states that learning strategies are systematic steps used by educators to create a learning environment that enables the learning process to occur and the achievement of specified competencies. With metacognitive strategies students are able to always design the best strategies in choosing, remembering, recognizing again, organizing the information they have and resolving the problems they face. This results in critical thinking skills of students who apply learning design based on metacognitive strategies better than students who apply conventional learning.

The second factor of the learning media used in the form of mathematical teaching aids is the cube, cuboid, prism, and pyramid. These teaching aids function to help speed up understanding in the learning process and serve a diverse student learning style. This makes students more active in learning and discovering mathematical concepts learned, so that without realizing it students' critical thinking skill increase.

4. CONCLUSION

Based on the results and discussion concluded that the design of metacognitive based learning is valid and feasible to use in the field, practitioners, namely teachers and students show a positive response to learning design. The results of the analysis of students' critical thinking skills after learning showed an increase in the high category. So it was concluded that the design of mathematical learning based on metacognitive strategies effective to improves students' critical thinking skills.

REFERENCES

Anggo, M., Kadir., Lambertus., Jazuli, A., Suhar., Kansil, Y. 2015. Metacognitive Strategies on Mathematics Learning to Improve Student's Environmental Awareness. International Journal of Education and Research. www. ijern.com. Vol. 3 No. 4, 133-142.

Arikunto, Suharsimi. 2006. Prosedur Penelitian: Suatu Pendekatan Praktik. Jakarta: PT. Rineka Cipta

Arikunto, Suharsimi 2009. Dasar-Dasar Evaluasi Pendidikan. Jakarta : PT. Bumi Aksara.

Facione, P. A. 2015. Critical Thinking. What it is and Why it Counts. Insight Assessment. http://www.insightassessment.com/ pdf_ files/what&why2006.pdf.

Fraenkel, J. R., Wallen, N. E., dan Hyun, H. H. 2011. How to Design and Evaluate Research in Education Eight Edition. New York: Mc Grew Hill Inc.

Gama, C. A., 2004, Integrating Metacognition Instruction in Interactive Learning Environment, D. Phil Dissertation, University of Sussex

Lessani,A., Yunus, A., Tarmiz,R., dan Mahmud, R. 2014. Why Singaporean 8th Grade Students Gain Highest Mathematics Ranking in TIMSS (1999-2011). International Education Studies; Vol. 7, No. 11.

Magno, C., 2010. The role of metacognitive skills in developing critical thinking. Faculty of the Counseling and Educational Psychology Department, De La Salle University-Manila, Philippines. 137-156

OECD. 2016. PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic and Financial Literacy. http.//dx.doi.org/10.1787/9789264255425-en.

Tinio, V.L. 2003. ICT in Education. Tersedia dalam http://www.apdip.net/publications/iespprimers/ICTinEducation.pdf pada 16 Februari 2018.

Toit, Stephan du dan Kotze, Gary. 2009. Metacognitive Strategy in the Teaching and Learning of Mathematics. Jurnal Phytagoras. [Online]. Tersedia: http://www.phytagoras.org.za/index. php/pythagoras/article/view/39