

# The Development of Math's Learning Materials Based on Cognitive Conflict for the Students at Junior High Schools

Silvia Rahayu<sup>1</sup>, Ahmad Fauzan<sup>2\*</sup>

<sup>1,2</sup> Magister Program of Mathematics Education, Universitas Negeri Padang, Indonesia

\*Corresponding author. Email: ahmadfauzan@fmipa.unp.ac.id

## ABSTRACT

Students often experience confusion in determining whether the solution or reason he presents is a right or wrong solution. Individual awareness of conflicting information that impacts the concept of the cognitive structure itself is called cognitive conflict. Based on these problems, through this study, learning tools were developed in the form of cognitive conflict-based lesson plans and LKPD for junior high school students. The research method used is design research. It realizes of three phases: the preliminary, the prototyping, and the assessment. The research subjects were students of class VII SMP / MTs. Herein, observation, interviews, checklists, videotaping, student work results, and mathematical abilities tests were used as the data collection method. The collected data were analyzed descriptively. This research resulted in cognitive conflict-based mathematics learning tools (RRP and LKPD) for junior high school students. It met the valid criteria with characteristics; its content reflects the state of the art knowledge about the cognitive conflict; each component in the device is consistent. The tools developed are also valid in terms of presentation and language.

**Keywords:** Learning Device, Cognitive Conflict, Mathematical Ability.

## 1. INTRODUCTION

Mathematics is one of the most important lessons. Thus, mathematics at every level of education is proven, from elementary school to tertiary education. Besides, the function includes in algebra become one of the essential materials in learning. Moreover, it is beneficial for solving the problems that encounter in real life.

Mathematics is a means of managing problems (problem-solving) [1], [2]. in this case, mathematics can be a medium for solving problems, both at school and in the environment of students. So this is one of the reasons for the importance of studying mathematics.

Problem-solving skills are fundamental in learning mathematics and useful in other fields of study and everyday life [3]. Therefore, the integration of problem-solving skills near the real world is the solution for solving the real world's problem and competition [4].

However, although problem-solving ability is crucial in learning mathematics, Indonesia's problem-solving ability is relatively low. Therefore, the student problem-solving abilities are still in the low category. It can be

seen from the results of [5] placing Indonesian eighth-grade students in 36 out of 49 participating countries with the average student score of 397, while the international average score is 500. It is not much different from the survey results [6], [7], [8] show that Indonesia is ranked 61 out of 65 participating countries. Based on the results of research by Mairing (2017), It tested 124 students in Indonesia, and 94% of them had low problem-solving abilities.

Therefore, the researcher did the preliminary study to see the students' mathematical problem-solving abilities, which is conducted on 21-22 July 2020 against students of class VII MTsN 2 Padang City by giving tests to students in the form of questions and interviews with teachers. It found that students' ability to solve mathematical problems is low. Figures 1 and 2 below show the examples of questions given and—the students' answers.

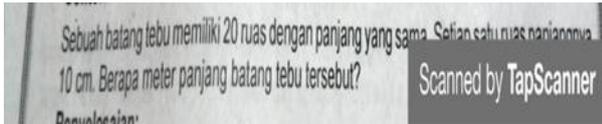


Figure 1 Examples of Problem-Solving Problems

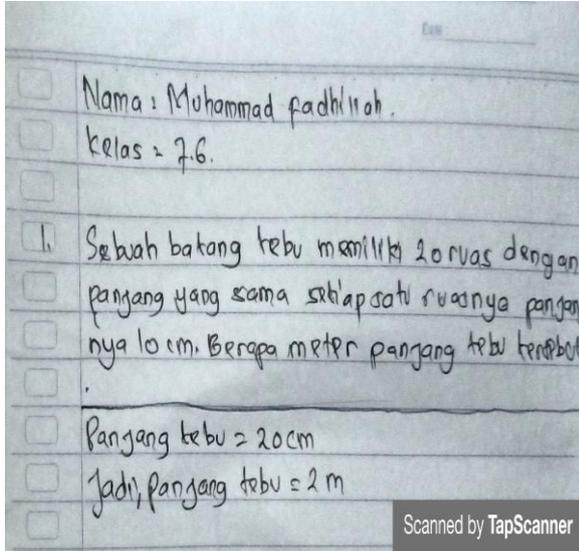


Figure 2 Examples of Students' Answers

Figure 2 explains that students have not been able to solve the problems given. Students do not identify the problem first, even though it is crucial to make it easier for them to understand what they want. However, students immediately answer by making a line drawing to substitute for sugarcane segments without identifying it first. Students only immediately conclude that the 20 segments of the sugarcane are the length of the sugarcane. This step is good, but students have drawn a line as a substitute for the sugarcane when determining the length of sugarcane. Students do not describe the sugarcane segment, so that students misunderstand that 20 is the sugarcane length.

Therefore, the students' answers explore the theoretical misconceptions that occur in students based on studying facts or events in an organized system. It is such as students being unable to calculate the multiplication of the value of segment and length of each segment of the sugarcane.

Besides, researchers made observations of the LKPD that teachers have used so far. Here is an example of LKPD, which can be seen in figure 3.

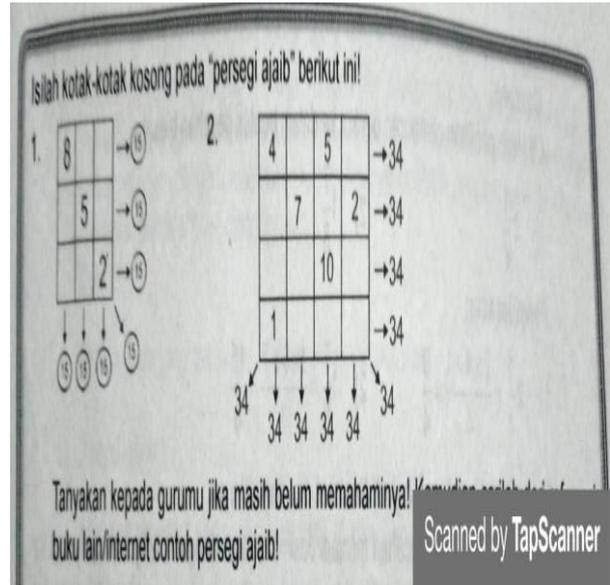
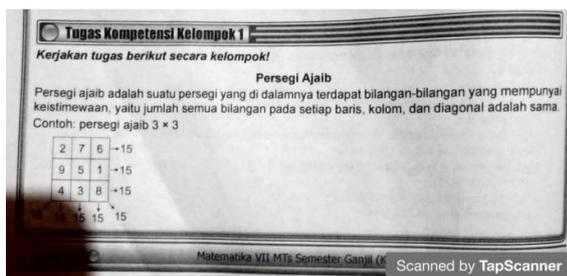


Figure 3 LKPD Used by Teachers

Based on Figure 3, it can be seen that the LKPD used is adequate but only suitable for conventional learning methods because it appears that the activities in the LKPD are less intensive to be involved in solving problems and even tend to be monotonous. The students were less active in constructing conceptual understandings and not knowing any misconceptions (misconceptions) that students previously had. It is also explained by [9], which states that one of the factors causing misconceptions in students is monotonous learning activities. Meanwhile, available textbooks generally encourage teachers to teach mathematics mechanically and algorithmically [10] [11].

One learning model suitable for improving problem-solving abilities and correcting students' misconceptions is through a cognitive conflict-based learning model. The cognitive conflict-based learning model is a learning model that starts from the mismatch of concepts (misconceptions) that students have with actual scientific concepts to end the concepts that students have become correct. As expressed by [12] and the Cognitive Conflict-Based Learning Model, a learning model contrasts misconceptions in students with actual concepts to solve problems.

Learning using a Cognitive Conflict-based learning model has been shown to increase students' ability to understand and strengthen concepts and solve students' problems [13], [14], [15]. In essence, students who learn with cognitive conflict-based learning models experience an increase in mathematical problem-solving abilities significantly. Based on these problems, the researchers designed cognitive conflict-based learning tools in class VII SMP / MTs.

## 2. METHOD

This research type is Development and Research (R&D). Development research attempts to develop and validate products used in education [16]. In this study, researchers used the Plomp development model. The product produced is a useful, practical, and persuasive student worksheet (LKPD) based on Rumah Gadang's ethnomathematics. The Plomp model's development has three stages: the initial investigation phase, the prototype development or prototyping phase, and the assessment phase [17].

Herein, the researcher carried out various analyzes to design cognitive conflict-based mathematics learning tools. The analysis in question includes curriculum analysis, concept analysis, and analysis of student characteristics. Based on the analysis results, the prototyping stage has designed a cognitive conflict-based mathematics-learning device. After that, the experts (mathematics education, learning technology, and language) validated the model prototype.

## 3. RESULTS AND DISCUSSION

The preliminary stage carried out some analysis to design the need for learning tools. It is: needs analysis, curriculum analysis, concept analysis, and student characteristics analysis. The needs analysis stage found that the teacher has designed mathematics lesson plans based on the 2013 curriculum. However, the teachers do not understand the 2013 curriculum implementation on learning activities., Therefore, the learning has not been optimally implemented according to the 2013 curriculum. Furthermore, teachers only got lesson plans through friends and MGMP meetings (Teacher Deliberation Subjects). Second, teachers have not used LKPD either made by them or purchased from publishers so that in the learning process, teachers only use textbooks.

Curriculum analysis is carried out to analyze core competencies (K.I.) and basic competence (K.D.) for class VII in the first semester. The results of the K.I. and K.D. The analysis is used to formulate indicators of competency achievement. The concept analysis results based on the curriculum used were four chapters studied in class VII Semester I. Due to time constraints, the material being tested was chapter 3 algebraic form (KD 3.5). In the algebraic form, there were eight material concepts to be made into 6 LKPD.

Besides, to know the student's characteristics in learning mathematics, the researcher did the student's analysis by giving an open questionnaire to class VII-A students at MTsN Padang City. The analysis result obtained several characteristics of students, namely (1) 9 students (60%) students liked A4-sized LKPD (Quarto), (2) 8 people (53.33%) students liked LKPD

with letter size 12, (3) 7 people (46.67%) students liked LKPD with Comic san ms font, (4) Students liked LKPD covers that were colored, eight people (53.33%) students liked the color of the students was green, (5) Students liked the colored sheet LKPD, seven people (46.67%) students liked the color of the students was white, (6) 9 students (60%) students prefer examples of questions or problems related to general contexts, (7) 10 students (66.67%) students prefer LKPD that use pictures to increase their attractiveness, and (8) 9 people (60%) students like pictures related to general contexts.

Based on the analysis above, The next stage was to design the learning tools needed. The learning device begins with a cover, then a table of contents, supporting information, concept discovery activities, and exercises. The following is an example of a cognitive conflict-based learning tool design based on preliminary research analysis.

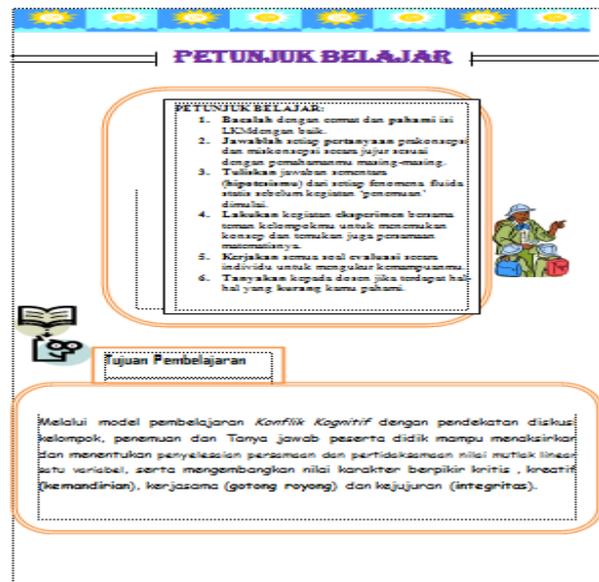


Figure 4. Examples of Study Instructions



Figure 5 The Example of LKPD Numbering

**AKTIVASI PRAKONSEPSI & MISKONSEPSI**  
(15 menit)

Pentunjuk!

- Bacalah dengan cermat setiap konsep bentuk aljabar berikut ini. Setiap fenomena terdiri dari beberapapernyataan.
- Padasetiap pernyataan,berilah tandache klist(□) pada salah satu kolom: **B**, **S** atau **T**, dengan keterangan :  
**B**: jika anda yakin pernyataan **BENAR**  
**S**: jika anda yakin pernyataan **SALAH**  
**T**: jika anda **TIDAK TAHU**

No	KONSEP BENTUK ALJABAR
1	Perhatikan percakapan dan gambar di bawah ini!

**Figure 6** Examples of Pre-Conception and Misconception Activities

Figure 6 is an example of pre-conception and misconception activities that aim to find out students' prior knowledge before learning.

**PENYAJIAN KONFLIK KOGNITIF**  
(25 menit)

Amati dan pikirkan konsep bentuk aljabar berikut ini!!

**1. Panen Strawberry**

Ratna dan keluarganya merupakan penduduk alahan panjang yang berprofesi sebagai petani, khususnya petani strawberry. Hari Sabtu Ratna dan kedua orang tuanya pergi memanen strawberry di ladang milik keluarganya. Biasanya Ratna dan keluarganya memanen Strawberry sehari penuh. Setelah memanen strawberry sehari penuh, hasil yang didapatkan oleh Ratna dan kedua orang tuanya adalah sebagai berikut:



**Ayah** : 2 karung strawberry, 3 keranjang, dan 10 strawberry.

**Ibu** : 1 karung strawberry, 2 keranjang, dan 5 strawberry.

**Figure 7** Examples of Presenting the Cognitive Conflict

Figure 7 is an example of presenting cognitive conflict in LKPD. Presenting cognitive conflict phenomena aims to create conceptual cognitive conflict in students before carrying out a conceptual change process to find new scientifically correct concepts.

**PENEMUAN KONSEP DAN PERSAMAAN**

**AYO BEREKSPERIMENI!**

Ayo lakukan eksperimen sederhana untuk menjawab keingintahuan mu (40 menit)

No	SOAL
1	Ibu dina ingin mengadakan acara makan malam keluarga besar bersama. Untuk itu, ibu Dina membeli 2 kardus gelas antik di Pasar. Setelah menghitung jumlah semua anggota keluarganya, Bu dina membeli lagi 4 kotak gelas antik dan 5 gelas antik di Alfamart. (jumlah gelas antik didalam kardus dan kotak berbeda). Permasalahan: 1. Dapatkah kamu menyatakan semua gelas antik yang dibeli bu Dina kedalam bentuk aljabar? 2. Apakah variabel gelas antik yang dibeli bu Dina di Pasar dan di Alfamart berbeda? 3. Dapatkah kamu menentukan manakah koefisien

**Figure 8** The Examples of Concept Discovery

Figure 8 is an example of presenting cognitive conflict in LKPD. Presenting cognitive conflict phenomena aims to create conceptual cognitive conflict in students before carrying out a conceptual change process to find new scientifically correct concepts.

**EVALUASI**

**AYO KITA BERLATIH**

Agar lebih paham, selesaikanlah persoalan bentuk aljabar berikut secara individu (Waktu : 20 menit).

No	SOAL
1	Animengikuti kelas seni lukis. Guru Animeminta Animembawa alat-alat berikut, yaitu 4 kuas lukis, 4 cat warna, 2 bukugambar untuk kelas seni lukis padahari selasa. Pertanyaan: a) Bagaimanakah bentuk aljabar untuk alat yang dibawa oleh Ani?? b) Jelaskan makna masing-masing variabel
2	Hari ini Badu belajar matematika di tempat les. Masing-masing kelas berisi 4 orang siswa. Hari ini guru les Badu

**Figure 9** Examples of Reflection

The final activity at the LKPD is the reflection or giving the training, which aims to make educators able to assess the extent of students' understanding of concepts after carrying out the concept discovery stage and their similarities.

The next stage conducted after designed the learning device is self-evaluation. It carried out on the device, aiming to see if there are still errors made on the prototype one learning device. Errors considered are clarity of writing, typing errors, use of images, misuse of terms, and punctuation errors. Thus, the result of self-evaluation and improvement is the learning device by name prototype 2.

After becoming prototype 2, five experts consisting of 2 mathematics lecturers, one mathematics teacher, one language lecturer, and one educational technology

lecturer validated the cognitive conflict-based learning device. The RPP validation results obtained an average value of 3.58, which is in the excellent category. Meanwhile, for the LKPD validation results, the average value is 3.5, which is also in the excellent category.

**Table 1** The Result of the Cognitive Conflict-Based LKPD Validation

No.	Aspect	Average	Criteria
1	Presenting	3.55	Excellent
2	Content	3.48	Excellent
<b>Total Average</b>		<b>3.5</b>	<b>Excellent</b>

#### 4. CONCLUSION

Based on the research results, this study concludes that the development of cognitive conflict-based learning tools (RPP and LKPD) is valid in terms of content and construct. The authors hope that the learning tool's evaluation can be continued to the next stage to see its practicality and effectiveness.

#### ACKNOWLEDGMENTS

We are very grateful to the Ministry of Research and Technology / National Research and Innovation Agency of the Republic of Indonesia (Kemenristek/BRIN) for the research's funding. Also, to lecturers and postgraduate program of Mathematic's Education at Universitas Negeri Padang who have supported the completion of this research.

#### REFERENCES

[1] Abdurrahman, M., 2012. Children with Learning Difficulties: Their Theory, Diagnosis, and Remediation. Rineka Cipta: Jakarta. (Originally in Indonesian)

[2] NCTM, 2005, Curriculum Focal Point for Prekindergarten through Grade 8 Mathematics, Reston, VA, United States

[3] Fadillah, S., 2009. Mathematical Problem Solving Abilities In Mathematics Learning. (Originally in Indonesian)

[4] Cahyani, Setyawati. 2016. The Importance Of Improving Problem-Solving Abilities Through PBL To Prepare A Superior Generation To Face MEA.Nt

[5] The trend in International Mathematics and Science Study (TIMSS), 2007, IEA

[6] Tilaar. 2006. PISA Surveys. [http://www.webometrics.info/top100\\_continent.asp?cont=asia](http://www.webometrics.info/top100_continent.asp?cont=asia). (Originally in Indonesian)

[7] \_\_\_\_\_. (2007d). PISA 2006 science competencies for tomorrow's world. Volume 1. Paris, France: OECD.

[8] \_\_\_\_\_. (2007e). PISA 2006. Volume 2. Paris, France: OECD.

[9] Anugeraheni. 2012. "Types of Student Errors in Solving Statistical Material Questions for Class XII SMA Negeri 1 Salatiga, Semester II Academic Year 2011/2012". Program Studi Pendidikan Matematika FKIP-UKSW. (Originally in Indonesian)

[10] Fauzan, Ahmad. 2002. Applying Realistic Mathematics Education (RME) in Teaching Geometry in Indonesian Primary Schools. Doctoral Dissertation. Enschede: University of Twente

Freudenthal, H. (1991). Revisiting Mathematics Education. China Lectures. Dordrecht: Kluwer Academic Publisher.

[11] Fauzan A, Plomp T and Gravemeijer K. 2013. Educational Design Research Part B: an Introduction ed T Plomp and N Nieveen (Enschede, SLO) p 159-178.

[12] Fadlan, A., 2011. "Cognitive Conflict Learning Model to Overcome Misconceptions in Physics Tadris Students Qualification Program S.1 Madrasah Teachers". Phenomenon: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam, November 2011, Vol.2, No.1, Hal.1 - 21 ISSN(P): 2527-3744; ISSN(E):2541-6499. (Originally in Indonesian)

[13] Putra, R.W. Y. 2014. "Application of Cognitive Conflict Learning to Improve the Problem Solving Ability and Mathematical Communication of High School Students." Program Studi Pendidikan Matematika Pascasarjana Universitas Pendidikan Indonesia. (Originally in Indonesian)

[14] Gusnidar, d.k.k.. 2017. Implementation of Cognitive Conflict Learning Strategies Aided by Wingeom Software in Improving Mathematical Problem Solving Ability. Jurnal Education Matematika dan Sains, September 2017, Vol.5, No.2, ISSN(P): 2337-9049; ISSN(E):2502-4671. (Originally in Indonesian)

[15] Azizah. 2015. The Effect of Cognitive Conflict Learning Strategies on Students' Mathematical Problem Solving Ability. Jurusan Pendidikan Matematika Fakultas Ilmu Tarbiyah dan Keguruan Universitas Islam Negeri Syarif Hidayatullah. (Originally in Indonesian)

[16] Arnon I, Cottrill J, Dubinsky E, Oktaç A, Fuentes, SR, Trigueros M, and Weller K 2014 APOS

Theory: A Framework for Research and Curriculum Development in Mathematics Education (New York: Springer)

- [17] Plomp T and Gravemeijer K 2013 Educational Design Research (Enschede: Netherland Institute For Curriculum Development (SLO))