The Development of Learning Device Based on Cognitive Conflict to Improve Mathematics Problem Solving Skills for Students in Madrasah Tsanawiyah

Silvia Rahayu[1*;] Ahmad Fauzan[1;] Yerizon[1;] I Made Arnawa[2]

[1] Universitas Negeri Padang, Padang, West Sumatera, 25132, Indonesia
[2] Universitas Andalas, Padang, West Sumatra 25175, Indonesia

Abstrak

According to the National Council of Mathematics Teachers (NCTM) 2005, Mathematics is a means of problem-solving. NCTM also emphasizes that problem solving cannot be separated from learning Mathematics because problem-solving is an integral part of learning Mathematics. This study aims to improve the mathematical problem-solving ability of students in the Madrasah Tsanawiyah by using a cognitive conflict-based learning model. The subjects of this study were students of class VII Madrasah Tsanawiyah. This type of research is development research. Data collection was carried out in 3 stages, the investigation stage, the prototype phase, and the assessment phase as the level of implementation and achievement in using the cognitive conflict-based learning model. The instruments used in this study were in the form of interview guidelines, questionnaires, and observation sheets. The data analysis carried out is the analysis of data on the validity, practicality, and effectiveness of learning tools. The results of problem-solving abilities can be seen from the results of students' final tests in each meeting which always increase. Based on the study's results, it can be concluded that Cognitive Conflict-based mathematics learning tools can improve students' mathematical problem-solving abilities.

Keywords: math learning devices; cognitive conflict-based learning; mathematical problem-solving skills

I. Introduction

Minister of National Education (2006-22), the objectives of learning mathematics in schools are: (1) so that students understand mathematical concepts, explain the relationship between concepts or algorithms broadly, accurately, efficiently, and precisely in solving problems; (2) students are able to use understanding patterns and properties, perform mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements, (3) students are able to solve problems (ability to understand problems, design mathematical models, solve models and interpret the solutions obtained); (4) students are able to communicate ideas with symbols, tables, diagrams, or other media to clarify circumstances or problems; and (5) students are able to have an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention and interest in learning mathematics, as well as an attitude of tenacity and confidence in problem solving.

Permendikbud Number 65 (2003), to

* Corresponding Author
Email Address : silviarahayu9393@gmail.com
Handphone : +62 89685571125

realize this goal, it is necessary to have good learning tools available. Good learning tools are one part of a learning plan. Teachers must consider several aspects in compiling learning tools (Lestari & Yudha-Negara, 2015). First, the learning tools that are arranged must follow the learning objectives. Second, the compiled learning tools must be able to motivate students in learning. Third, the learning tools compiled must be easy for teachers and students to implement. Afriansyah (2013), through good learning tools, the quality of learning outcomes can be improved. Both in the form of knowledge, skills, and student attitudes. Rima (2016), through good learning tools, conducive learning opportunities can be created, such as students being more motivated in learning, learning materials being easier to understand, students being more active, and teacher and student interactions are increasing.

Several expert opinions regarding the importance of a learning tool in the learning process. According to Sumarmo (2012), Mathematics learning is essential to be given to students because it is advantageous as a provision for current and future students. Among them is to improve the ability to reason logically, systematically, critically, meticulously, and think objectively. Mudlofir (2016), this ability is indispensable for students in the face of today's technological advances. In addition, it is also to produce graduates who can compete, be creative, and be civilized with the times.

In line with Sumarno's view, Setiana (2021) also stated that through critical thinking skills, students would be able to solve various problems independently. Students' creative power can be born through the ability to think critically. Hendriana & Soemarmo (2014) the ability to solve mathematical problems among students is essential to mathematics learning. This step is something fundamental to create in every learning.

However, in its implementation in schools today, students' ability to solve mathematical problems is still low. The Trends in International Mathematics and Science Study results show that students' mathematics learning achievement in

Indonesia is ranked 45th out of 50 countries. Likewise, the results of the Trend in International Mathematics and Science Study (TIMSS), a study organized by the International Association for the Evaluation of Educational Achievement (IEA) in 2007, showed students' ability to solve their problems in learning is still low. Mullis et al. (2008), the position of Indonesian class VII students is ranked 36th, out of 49 countries, with an average score of 397, from an international average score of 500.

Furthermore, the results of the PISA survey (2015) placed Indonesian students in 61st place out of 65 countries (Balitbang, 2015). Likewise, Mairing's research (2017) results in 124 countries; only 94% of Indonesian students cannot solve their mathematical problems well. Furthermore, research was conducted by Fauzan and Tasman (2012) on the Mathematical ability of junior high school / MTs students in West Sumatra Province. The result is that students' ability to solve mathematical problems is still low; 40.957% of students obtained low scores, 34.574% obtained average scores, and 24.468% obtained high scores.

Fauzi (2011), the low ability of students to solve mathematical problems can be caused by various things. Among them is a poor attitude of students, which is to think that learning mathematics is not very important to qualify for graduation. In addition, the learning carried out by teachers in the classroom still focuses on procedural abilities and is still one-way.

According to Nasution (2013), improving students' ability to solve their problems requires thinking skills among students, such as the ability to observe, report, describe, analyze, classify, interpret, criticize, and the ability to conclude. The steps in solving the problem are (1) understanding the problem, (2) drawing up a settlement plan, and (3) implementing the plan (Polya in Rahima). Gusnidar (2017) et al. state that cognitive conflict learning can improve students' mathematical problem-solving abilities.

Mufit (2018), in addition to the cognitive conflict model, the improvement of students' mathematical problem-solving ability can also be improved through several other approach models. The development of cognitive conflict-based learning tools is significant because this learning tool is expected to help improve students' mathematical problem-solving skills. The lesson plan will be designed according to the stages in the cognitive conflict model so that teachers can more easily direct students to be active in learning. Baser (2006), the lesson plan will be designed as well and clearly as possible so that teachers can more easily apply it in the implementation. This is because teachers refer to lesson plans in the implementation of learning. The designed lesson plan will also pay attention to the characteristics of students so that students become happy and enthusiastic about the learning held by the teacher. The students' worksheet contains all the explanations about the learning materials for one semester in class VII madrasah Tsanawiyah. Its use can be done during group discussions or independent studies. Cognitive conflict-based students worksheet can help learners in finding concepts from the material. The questions in the students' worksheet will refer to problems that can explore the mathematical problem-solving ability of students so that this students' worksheet can improve students' mathematical problem-solving skills.

Research that is relevant to this research at the national level regarding the influence of students' mathematical problem-solving ability using cognitive conflict learning strategies is the research of Gusnidar et al. (2017), Azizah (2005) & Susilo (2016). Based on the results of the research they have done, it is stated that the mathematical problem-solving ability of learners can improve after using cognitive conflict learning strategies.

Research that is relevant to this research at the international level regarding the influence of students' mathematical problem-solving abilities using cognitive conflict learning strategies is Wahyu (2018) & Fraser (1983), with the result that students' mathematical problem-solving ability can be improved by using cognitive conflict learning strategies. There is a relationship between the research that has been carried out (relevant research) and the research that will be carried out by the author, which is both based on Cognitive Conflict to improve the mathematical problem-solving ability of students. Previous research was focused only on tests only. This research was conducted by looking at whether the lesson tools used impacted students' problem-solving abilities and helped students in learning.

II. Research Methods

This research is a type of development research. The learning tools developed in this study include a lesson plan and a student's worksheet. The development model is a Lesson Plan and Students Worksheet for SMP / MTs. The development model that the authors used in this study is the Plom model. Plomp uses 3 stages of development, namely: (1) preliminary stage or preliminary investigation, (2) stage of preparing prototype or prototyping stage, and (3) assessment stage or assessment.

In the preliminary phase, the process carried out is (a) needs analysis, (b) curriculum analysis, (c) student analysis, and (d) concept analysis. In the development phase or making prototypes, namely: (a) Prototype I., (b) Prototype II: one-to-one evaluation. (c) Prototype III: evaluation of small groups, and (d) Prototype IV: trial of cognitive conflict-based Mathematics learning devices in large classes. The goal is to determine the validity and practicality of learning devices compiled through their experiments in the field.

In the assessment phase carried out are (a) practicality test, (b) effectiveness test, (c) product trial, and (d) test subject (learner).

93

The instruments at the introductory stage are observation sheets, interview sheets, interview guidelines, and questionnaires. The instruments at the prototype development stage are the self-evaluation sheet, lesson plan, and students' worksheet validation sheet. Practical instruments are interview guidelines, learning observation sheets, educator interview sheets, teacher response questionnaires, and student response questionnaires. The instrument for testing the effectiveness of the learning device is a test of problem-solving ability, which contains the test's purpose, the grid of questions, and the creation of a scoring rubric. Next is the trial stage of the question for class VII MTs 2 Padang learners.

Data analysis is carried out in two ways, namely (1) analysis of validity data and (2) analysis of practicality data. Invalidity data analysis, the steps: determine the validation value contained in the validation sheet, the average number of scores the validator gives on each item, and the learning device's validity. Practicality data analysis is carried out in steps: analysis of teacher and student response questionnaires, analysis of interview results data, and analysis of lesson plan implementation observation sheets. At the same time, the analysis of effectiveness data is carried out at the small group and field test stages.

III. Results and Discussion
A. Results:

The results of the study include 3 aspects, namely: (1) the validity of learning devices, (2) the practicality of learning devices, and (3) the effectiveness of learning devices.

(1) The Validity of Learning Devices
The results of the learning device validity are presented in Table 1.

Table 1
Learning device validation results

Learning Devices	Average assessment results	Criterion
Lesson Plan	3.35	Very valid
Students Worksheet	3.45	Very valid

(2) The Practicality of Learning Devices

The results of the learning device practicality are presented in Tabel 2.

Table 2
Learning device practicality results

Learning Devices	Respondent	Average	Criterion
Lesson Plan	Teachers	90,55%	Very practical
Students Worksheet	Teachers	87,50%	Very practical
Students Worksheet	Students	86,94%	Very practical

3) Effectiveness of Learning Devices
The results of the learning device effectivity are presented in Table 3.

Table 3
The result of student's mathematical problem-solving ability test

Students	1	2	3	4	5	6
Score	86	80	83	80	93	90
Criterion	Succeed					

Based on the results of the student's mathematical problem-solving ability test, it was obtained that 100% of students had a score above the set KBM, which was 77, and can be seen in table 03 above. This shows that learners already have good mathematical problem-solving skills after utilizing mathematical learning tools with cognitive conflict-based learning models. That is, mathematical learning tools with cognitive conflict-based learning models have been effective in learning focused on looking at mathematical problem-solving abilities.

B. Discussion
a) *The Validity of Learning Devices*
(1) **Validity of lesson plan**

The validity of a cognitive conflict-based mathematics lesson plan is reviewed from various aspects, namely the identity of the subject, essential competencies, indicators of competency achievement, learning objectives, learning materials, models, approaches, strategies and learning methods, conformity of learning activities steps with Cognitive Conflict-based learning, learning resources, learning media, assessment, and lesson plan language and writing.

The completeness of the components and format of the mathematical lesson plan is adjusted to Permendikbud No.22 of 2016. Once revised, then the learning device is discussed with experts. In this case, the validity of the lesson plan is carried out by 5 validators, namely 3 Mathematics lecturers, 1 Indonesian lecturer, and 1 Lecturer in Educational Technology. The validity results by the 5 validators showed that the lesson plan developed had been very valid.

(2) **Validity of students' worksheets**

The criteria for the validity of the students' worksheets developed are seen from content, language, presentation (didactic), and aspects of their appearance. Similar to the lesson plan, the validity of students' worksheets is determined by 5 validators, namely 3 Mathematics lecturers, 1 Indonesian lecturer, and 1 Lecturer in Educational Technology. The results of the validity of the student's worksheet by the 5 validators showed that the students' worksheet developed was very valid.

The results of the lesson plan and student's worksheet validation can be seen in table 01.

Table 01 above shows that the lesson plan and student's worksheet learning devices that have been compiled are very valid. The average lesson plan rating result was 3.35. at the same time, the average result of the student's worksheet assessment is 3.45. Thus, both learning devices are very feasible to use in helping students solve their problems in learning Mathematics in the classroom.

b) Practice of Learning Devices

Practicality is the level of usefulness of a technical learning device in learning. The learning devices tested for practicality are lesson plans and students' worksheet mathematics based on cognitive conflicts.

The criteria to assess practicality in developing this device is implementing learning using mathematical learning devices with cognitive conflict-based learning models. Ease refers to the ease with which the device is used by teachers and observations made during the learning process in the classroom.

The practice of students' worksheets developed has been declared practical based on practicality questionnaires given to learners who are the subject of trials on device research with cognitive conflict-based learning models.

The results of the recapitulation of the questionnaire given obtained a value of 87.50% with a convenient category. This can be seen in table 2. Table 2 shows that the lesson plan and students' worksheets that have been compiled have been convenient. This is shown by the average value of the assessment results. For the average lesson plan score, the teacher's response result is 90.55%. The average student worksheet score of teacher response results is 87.50%. Likewise, the average student worksheet score of student response results, which is 86.94%. Thus, the level of practicality of the compiled learning devices is convenient. Lesson plans and student worksheets have been arranged to improve learners' ability to solve problems in mathematics learning.

c) Effectiveness of Learning Devices

Effectiveness of learning devices with cognitive conflict-based learning models, measured by the extent to which learning devices can achieve Math learning goals. The increase in students' mathematical problem-solving skills can be seen from the increase in students' worksheet scores and the results of mathematical solving skills tests after learning.

Based on the results of the Mathematical solving ability test obtained by students, which can be seen in table 03, shows that 100% of students have had a score above the set KBM, which is 77. Based on the acquisition of final test scores obtained by students, it can be concluded that the learning tools in the form of lesson plans and student worksheets that have been prepared are very effective.

Learning devices like lesson plans and students' worksheets are very well used to improve students' ability to solve mathematics problems. Thus, the results or achievements of future learners in Mathematics subjects will be excellent.

Curriculum objectives will be easily achieved.

Based on the test results on the validity of learning devices, the practicality of learning devices, and the effectiveness of the learning tools that the researcher has compiled, it can be seen that the lesson plan and student worksheet device models that the researcher compiled are valid. Likewise, with its practicality, that is, it shows convenience, and from the aspect of its effectiveness that learning tools such as lesson plans and student worksheets have shown excellent results. Thus, the cognitive conflict-based learning tool model that the researcher has compiled is very appropriate to be used to improve the ability of students to solve mathematics learning problems for students in MTs, especially in MTSN 2 Padang. The learning tools that researchers compile can undoubtedly be a solution for students in solving math problems in class. If this can be done, of course, in the future the achievement of learning mathematics subjects carried out by students will be better than before.

We hope that the results of the Trend in International Mathematics and Science Study (TIMSS) organized by the International Association for the Evaluation of Educational Achievement (IAEEA) and the upcoming PISA (2023) survey in 2023 can put Indonesia's students in a better or excellent ranking. Likewise, from the results of research conducted by previous researchers. Suppose the research results that have been obtained by Fauzan and Tasman in 2012 in West Sumatra Province on the Mathematical ability of junior high school / MTs students still tend to be low in terms of solving mathematical problems. In that case, we hope the research results conducted in 2023 will be very good. This is due to more appropriate learning tools and helping students solve mathematics learning problems. One is through the use of mathematics learning tools that researchers have compiled.

IV. Conclusion

The cognitive conflict-based learning tool model researchers have compiled is very appropriate for students of class VII MTs to improve their mathematical problem-solving skills

in the classroom. The reason is that this learning tool is very valid, judging from the aspect of the validity test. The results of the practical test also show that it is convenient. Likewise, the results of the effectiveness test also showed that it was very effective. The development of this tool can also make learning mathematics easier and more effective and can be used as an indicator to improve student learning outcomes.

The researcher carries out several development stages, from the preliminary analysis, design, and assessment stages. At these stages, many steps are taken to produce a valid, practical, and effective product. This research can provide an overview to education providers to improve the quality of learning. Other class teachers can develop this device without neglecting validity, practicality, and effectiveness. Teachers can validate learning tools with peers and lecturers in mathematics education. This development is carried out in line with the implementation of learning in the classroom following the goals that have been set. This development adds experience to teachers learning that can improve students' problem-solving skills. The development of this Cognitive Conflict-based device aims to assist students in building their knowledge independently in solving Mathematical problems. In addition, teachers can use various ways or methods to foster student motivation, ranging from games or other fun activities.

References

Afriansyah, E. A. (2013). Design research: Place value in decimal numbers using metric system. *In International Seminar on Mathematics, Science, and Computer Science Education MSCEIS*, Universitas Pendidikan Indonesia (UPI) Bandung.

Agustami. dkk. (2021). Analisis kemampuan pemecahan masalah matematis siswa dalam menyelesaikan soal materi lingkaran. *JPMM: Jurnal Prodi Pendidikan Matematika IKIP PGRI*

Pontianak. Retrieved from https://jurnal.mipatek.ikippgriptk.ac.id/index.php/JPPM/ article/view/279

Amam, Asep. (2017). Penilaian kemampuan pemecahan masalah matematis siswa SMP. *Jurnal Teorema: Teori dan Riset Matematika Universitas Galuh*. Retrieved from https://jurnal.unigal.ac.id/index. php/teorema/article/ view/765

Cahyani, H. dan R. W. S. (2017). Pentingnya peningkatan kemampuan pemecahan masalah melalui PBL untuk mempersiapkan generasi unggul menghadapi MEA. *Prosiding Seminar Nasional Matematika X 2016*. https://journal.unnes.ac.id/sju/index.php/prisma/article/view/21635

Devina, P. S. elfis; K. (2021). Pengembangan perangkat pembelajaran berorientasi berpikir tingkat tinggi model problem based learning materi peluang kelas VIII SMP. *Jurnal Gantang*, *6*(1). https://doi.org/10.31629/jg.v6i1.2867

Diyastanti, A. (2018). *Meningkatkan kemampuan pemecahan masalah dan self- esteem matematis siswa kelas VII dengan model eliciting activitiy*. (Skripsi). Universitas Negeri Semarang.

Fatimah, Ade Evi. (2016). Peningkatan kemampuan pemecahan masalah matematis dan kemandirian belajar siswa SMK negeri 1 Percut Sei Tuan melalui pendekatan differentiated instruction. *MES: Journal of Mathermatics Education and Science* UISU Medan. Retrieved from https://jurnal.uisu.ac.id/index. php/mesuisu/article/view/111

Fauzan dan Tasman. (2012). Laporan penelitian: analisis literasi matematis siswa SMP di Sumbar. Laporan Pernelitian. UNP

Fauzi Amin.(2011). Peningkatan kemampuan koneksi matematis dan kemandirian belajar siswa dengan pendekatan pembelajaran metakognitif di sekolah menengah pertama. Disertasi pada PPs UPI Bandung: Tidak diterbitkan.

Gusnidar. (2017). Implementasi strategi pembelajaran konflik kognitif berbantuan software wingeom dalam meningkatkan kemampuan pemecahan masalah matematis. *Jurnal Edukasi Matematika Dan Sains*, *5*(2). Retrieved from http://e-journal.unipma.ac.id/index.php/JEMS/article/view/1988

Hendriana, H, and U Soemarmo. (2014). *Penilaian pembelajaran matematika*. Bandung: Refika Aditama

Hidayat, Wahyu dan Ratna Sariningsih. (2018) Kemampuan pemecahan masalah matematis dan adversity quotient siswa smp melalui pembelajaran open ended. *JNPM: Jurnal Nasional Pendidikan Matematika Universitas Gunung Ja*ti. Retrieved from https://jurnal.ugj.ac.id/index.php/JNPM/article/view/1027/0

Jackson Pasini Mailing. (2017). Thinking process of naive problem solvers to solve mathematical problems. *International Education Studies*, *10*(1). https://doi.org/10.5539/ies.v10n1p1

Latifah, Teli dkk. (2021). Kesulitan dalam kemampuan pemecahan masalah matematis siswa pada materi statistika. *JARME: Journal of Authentic Research on Mathematics Education*. Retrieved from https://jurnal.unsil.ac.id/index.php/jarme/article/view/3207

Lathifah, Hanum Faizunnur. dkk.. (2021). Analisis faktor yang mempengaruhi kemampuan pemecahan masalah matematis siswa SD *PRIMARY: Jurnal Pendidikan Guru Sekolah Dasar UNRI*. Retrieved from https://primary.ejournal.unri.ac.id/index.php/JPFKIP/article/view/ 8105

Lestari, K. E. dan Yudhanegara, M. R. (2015). *Penelitian pendidikan matematika*. Bandung: Refika Aditama.

Mairing, J. P. (2017). Thinking process of naive problem solvers to solve mathematical

problems. *International Education Studies*, *10*(1).

Meika, Ika. dkk. (2021). Kemampuan pemecahan masalah matematis siswa dengan menggunakan model pembelajaran SSCS. *Jurnal Cendekia: Jurnal Pendidikan Matematika.* Retrieved from https://j-cup.org/index.php/cendekia/article/view/388

Mudlofir, A. (2016). *Desain Pembelajaran Inovatif*. Jakarta: PT Raja Grafindo Persada

Nasution, Haryati Ahda (2013). Perbedaan peningkatan kemampuan pemecahan masalah dan komunikasi matematik siswa pada pembelajaran berbasis masalah dan pembelajaran langsung pada siswa SMP [Universitas Negeri Medan]. Retrieved from http://digilib.unimed.ac.id/4085/1/1.8116171007 Judul.pdf

Nengsih, Luluk Wahyu. dkk. Tahun 2019 melakukan penelitian berjudul kemampuan pemecahan masalah matematika siswa sekolah dasar dengan gaya kognitif field dependent. *Jurnal Pendidikan: Teori, Penelitian dan Pengembangan Universitas Malang*. Retrieved from http://journal.um.ac.id/index.php/jptpp/article/view/11927/5664

Permendiknas No. 22 Tahun 2006 tentang standar isi untuk satuan pendidikan dasar dan menengah. 2006. Jakarta: Depdiknas

Plomp, Tjeerd & Ninke Nieveen. (n.d.). *Educational Design Research. Netherlands Institute For Curriculum Development (SLO)*.

Putra, Harry Dwi. dkk. (2018). Kemampuan pemecahan masalah matematis siswa SMP pada materi bangun ruang. *JIPM: Jurnal Ilmiah Pendidikan Matematika*. Retrieved from http://e-journal.unipma.ac.id/index.php/jipm/article/view/2007/0

Rahmani, Wirda dan Nurbaiti Widyasari. (2018). Meningkatkan kemampuan pemecahan masalah matematis siswa melalui media tangram. *FIBONACCI: Jurnal Pendidikan Matematika dan Matematika*. Retrieved from https://jurnal.umj.ac.id/index.php/fbc/article/view/2402

Rima, E. 2016. *Ragam media pembelajaran*. Jakarta: Kata Pena.

Rokhima, N. dan H. F. (2017). Pemecahan masalah matematika siswa smp ditinjau dari kecerdasan intrapersonal. *Seminar Nasional Pendidikan, Sains Dan Teknologi Fakultas Matematika Dan Ilmu Pengetahuan Alam Universitas Muhammadiyah Semarang*. Retrieved from https://jurnal.unimus.ac.id/index.php/psn12012010/article/view/3068

Setiana, Dafid Slamet. (2021). Analisis efektivitas e-students worksheet (lembar kegiatan peserta didik elektronik) berbasis etnomatematika Batu Akik ditinjau dari kemampuan awal siswa. *Jurnal Gantang*, *6*(2). https://doi.org/10.31629/jg.v6i2.3566

Slameto. 2010. *Belajar dan faktor-faktor yang mempengaruhinya*. Jakarta: Rineka Cipta

Sumarmo, U. (n.d.). 2012. Pendidikan karakter Serta Pengembangan Berfikir dan Disposisi Matematik Dalam Pembelajaran Matematika.