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THE DEVELOPMENT OF CONCEPTUAL-CONFLICT-BASED LEARNING DEVICE IN MATHEMATICAL PROBLEM SOLVING

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Abstract:

This study aimed to develop conceptual-conflict-based learning device in mathematical problem solving on the subject of equations in three variables systems in the class X at MIA MAN 1 Makassar which was valid, practical and effective. The type of this study was research and development which consisted of: Lesson Plans, Student Book, Student Worksheet, and Learning Outcomes Test. The developmental model used was 4D model which consisted of difining, designing, developing and disseminating. The result of this study obtained that learning device was valid criteria based on the assessment from two validators. While the result of the limited trial showed the learning device was practical, but there were still several suggestions from observers that need to be considered to improve the practicality of the device. It was also effective which was proved by the completeness of learning outcomes that has been achieved, students' activity was as expected, the ability of teachers to manage the learning was in a high category and the students' responses was in a positive category.

Keywords: Conseptual-Conflict-Based Learning, Problem Solving

Abstrak:

Penelitian ini bertujuan menghasilkan perangkat pembelajaran matematika berbasis konflik konseptual dalam pemecahan masalah pada pokok bahasan sistem persamaan linear tiga variabel kelas X MIA MAN 1 Makassar yang valid, praktis dan efektif. Jenis penelitian ini adalah penelitian dan pengembangan yang terdiri atas: Rencana Pelaksanaan Pembelajaran, Buku Siswa, Lembar Kerja Peserta Didik, dan Tes Hasil Belajar. Model pengembangan yang digunakan adalah model 4D yang terdiri dari tahapan perancangan, pendefinisian, pengembangan dan penyebaran. Hasil penelitian yang diperoleh adalah perangkat pembelajaran memenuhi kriteria valid berdasarkan penilaian oleh dua orang validator. Sedangkan hasil yang diperoleh pada uji coba terbatas, yaitu perangkat pembelajaran sudah praktis, tetapi masih ada beberapa saran pengamat yang perlu diperhatikan untuk meningkatkan kepraktisan perangkat. Perangkat pembelajaran sudah efektif dilihat dari ketuntasan hasil belajar yang telah tercapai, aktivitas siswa sudah sesuai yang diharapkan, kemampuan guru mengelola pembelajaran sudah dalam kategori tinggi dan respon siswa sudah dalam kategori positif.

Kata Kunci: Perangkat Pembelajaran Konflik Konseptual, Pemecahan Masalah

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INTRODUCTION

Today the development of science, technology and art is increasingly rapid and has ushered humanity into an era of global competition in various fields of life. The main step that must be prepared is the availability of strong human resources that is strong, sturdy, time-tested and has reliable capabilities in their fields. For this reason, in the world of national education, it is demanded to create teachers as competent and educational learning facilitators. Competent and professional teachers who are also inspiring are referred to learning teachers as proclaimed by the Indonesian government in an effort to improve the quality of education.

Permendiknas Number 70 of 2013 (Kemendiknas, 2013) explain that the 2013 Curriculum aims to prepare Indonesian people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative, and affective and able to contribute to community life, nationhood, and world civilization. In addition, Lerner (in Abdurrahman, 2009) suggests that the curriculum in the field of mathematics should include three elements, (1) concepts, (2) skills, and (3) problem solving.

Therefore, the urgent ability achieved by students from the results of the learning process in schools is mastery of concepts, skills, and problem solving skills. This ability is a competency that is mastery of knowledge (Abrar, 2016). Problem solving is a process of accepting problems as a challenge to be solved and is a common goal in teaching mathematics (Angraini & Bernard, Nur, 2016). Furthermore, Cooney (Sutrisman & Tambunan., 1987) says that problem solving is the process of accepting problems and trying to solve them. While Polya (1973) defines problem solving as an effort to find a way out of a difficulty in achieving a goal that is not immediately achievable. It is very important to study mathematics specifically about solving mathematical problems in life (Lahinda & Jailani., 2015) . Thus, problem solving is the main goal of all mathematics learning and is an integral part of all mathematical activities.

One of alternative learning strategies that can be designed to strengthen problem-solving skills for students while at the same time providing an

accompanying impact on the character that can prevent violence due to unresolved social conflict among students is a conceptual conflict strategy based on cognitive conflict theory (Liang, 2016). This strategy can be applied in problem-based learning by applying cognitive conflict strategies called the Conceptual Conflict Model in Mathematical Problem Solving.

The Conceptual Conflict Model in Mathematical Problem Solving model in the study from Asdar (2015) is based on cognitive conflict theory developed by Piaget (1985) as a strategy in learning. Cognitive conflict strategy is an alternative that can be taken by confusing the understanding of the children have with a new idea or information that is relevant in a different perspective. The purpose of giving this conflict strategy is to strengthen the understanding of the initial concept that is owned if the conflict experienced is successfully resolved under conditions of mental balance.

Sela & Zaslavsky (2007) describe their opinions on cognitive conflict which say cognitive conflict results in a state of disequilibrium - a Piagetian term meaning lack of mental balance. It is essential to the occurrence of what Piaget termed 'true learning', that is the acquisition and modification of cognitive structures and Lee, Gyoungcho (2003) describe that cognitive conflict is defined as a conflict between cognitive structure (i.e., an organized knowledge structure in the brain) and environment (i.e. a experiment, demonstration, peer's opinion, book, or something like that), or a conflict between conception in cognitive structure.

Based on the limitations of cognitive conflict stated above the limits of cognitive conflict used in this study is a conflict in the mind of someone who has understandings of a concept or its application that does not integrate with each other. Asdar (2012) says that the conflict in mind will strengthen conceptual understanding in solving mathematical problems.

Overcoming and resolving a conflict is not a simple matter, it depends on the willingness and openness of the disputing parties to resolve the conflict, the severity of the weight or level of the conflict (Wahyuni, 2017). Therefore, familiarizing students in conflict situations is a necessity accompanied by the formation of character values that leads to the discovery of solutions to conflict. Dealing with conflict, there are five actions we can take, namely competing, avoiding conflict, accommodation, compromising, and collaborating. These five actions can be accommodated in conflict learning strategies

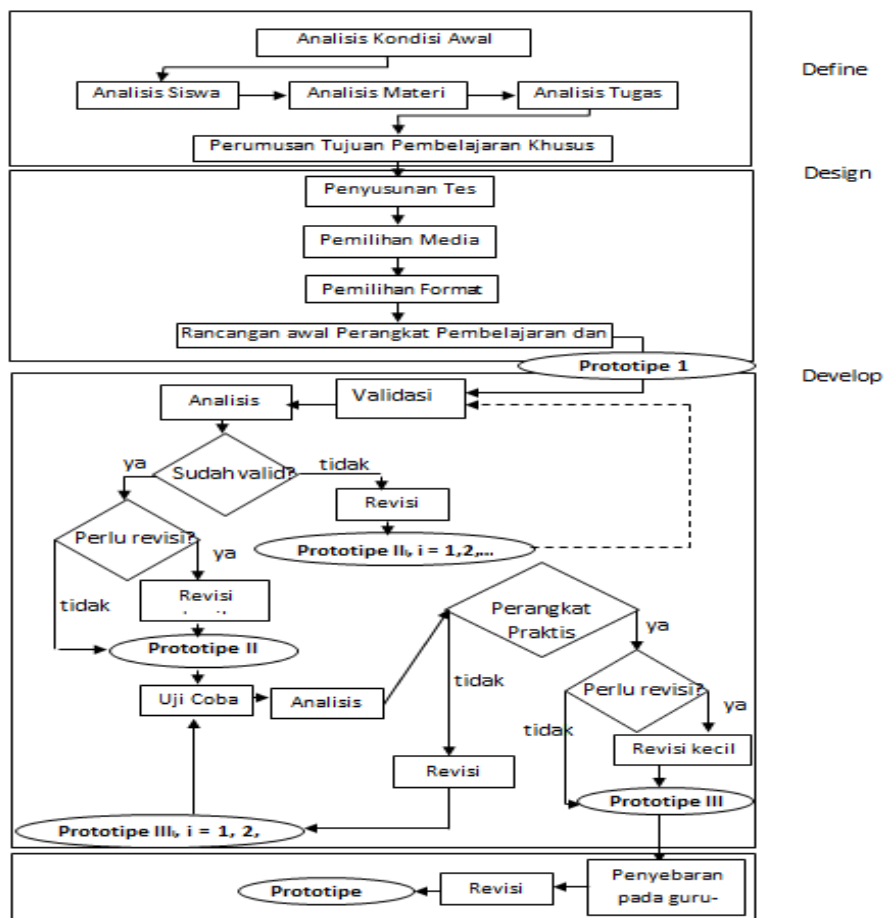
The problem in the MAN 1 Makassar school is that most students only memorize formulas to solve problems. In solving questions with many formulas most students also have not been able to finish well. This happens because

students assume that mathematics is a subject that has many formulas, no concepts. This indicates that the ability of students to concepts, principles and mathematical skills is still very low, so it is necessary to have devices that can foster the creative attitude of students, one of them is a problem-based learning device.

The purpose of this article is to develop conceptual-conflict-based learning device in mathematical problem solving (valid, practical, and effective), which includes: (1) Lesson Plan, (2) Student book, (3) Student Worksheet, and (4) Learning Outcome Test at the MAN 1 Makassar school.

RESEARCH METHODS

This research includes the type of development research. The research design used in connection with the objectives of the development research mentioned above is the 4D model of Thiagarajan. The subjects of this study were students of Madrasah Aliyah Negeri 1 Makassar in the academic year 2017/2018. There are two components that will be developed in this development research, namely learning devices and instruments that will be used to assess the quality of learning devices. The device development model used in this study refers to the development of four D Models (4-D models) consisting of four stages, namely define, design, develop and disseminate, as stated by Thiagarajan.



Picture 1. Research Design

RESULT AND DISCUSSION

Result

The description of the development stage in this study is as follows:

a. Defining Phase (Define)

At this defining stage a check and definition of the conditions for developing a learning device based on a model of conceptual conflict have been carried out in solving mathematical problems. At this stage also carried out literature studies, relevant research studies, and observations to target schools which include: (1) preliminary analysis, (2) analysis of students, (3) material analysis, (4) task analysis, (5) specification of learning objectives.

b. Design Stage (Design)

The results of the design stage include several design activities, namely:

1) Draft of Lesson Plan

The format of the lesson plan developed in the draft lesson plan is based on the 2013 curriculum consisting of several components, namely core competencies,

basic competencies, indicators of achievement of competencies, learning objectives, learning methods, learning media, learning resources, and learning activities.

2) Student Book

Designing student books with material systems of three-variable linear equations refers to the basic competencies of a three-variable linear equation system. Student books are prepared based on the mathematics curriculum that applies in accordance with the level of education, namely high school / MA. The material in the student book is formulated in the form of problems that will be solved by students or activities that are done individually or in groups with the guidance of the teacher. Problems that are appropriate for daily life will be able to develop creativity in solving students' problems. The development of this student book considers the learning model used in the study, the Novick learning model.

3) Student Worksheet

The selection of learning material should be guided by the understanding that the learning material provides activities that are student-centered. So student worksheet system of three-variable linear equations designed contains questions that invite students to think systematically to solve a problem related to daily life.

4) Learning Outcomes Test

The THB design of the three-variable linear equation system developed refers to the indicators of achievement of system competencies in three-variable linear equations with problem-based models.

c. Development Stage (Develop)

This stage aims to produce prototypes of learning devices based on conceptual conflict models in solving mathematical problems that have been validated by experts and practitioners and revised so that they are suitable for use in the learning process.

1) Analysis of the Results of Validity Data on Problem Based Learning Devices Based on validation I and II and the validator's comments on the feasibility of problem-based mathematics learning devices summarized as follows in table 1 and table 2.

Tabel 1. Suggestions for the Improvement of *Prototype I* by Validator

Aspect	Recommendation for Improvement
Lesson Plan	Adjust the learning model that will lead to conceptual conflict The step of learning is more operational
Student Book	1. The concept and procedure for writing should be considered 2. All images must be equipped with the source. It is better that problems presented in the book of the students is a matter of everyday life in accordance with the intelligence of learners
Student Worksheet	1. Clarify the picture on the LKPD 2. Clarify the question and the LKPD as short as possible in the form of information or illustrations and questions
Learning Outcome Test	1. Clarify the question grid 2. Adjust the problem with the learning model used 3. Adjust the problem with the indicators you want to achieve
Implementation	The activities of students who come out of the learning process need to be considered, therefore there needs to be more attention from the teacher

Tabel 2. Suggestions for Improving the *Prototype II* by Validator

Aspect	Recommendation for Improvement
Lesson Plan	1. The learning model is appropriate for generating conceptual conflict 2. The learning step is operational
Student Book	1. The concepts and procedures for writing are good 2. All images have the source 3. Problems that are presented in the student's book are problems of daily life in accordance with the catchment of students
Student Worksheet	1. The picture on the LKPD has been clarified 2. Questions on LKPD are simple and clear
Learning Outcome Test	1. The question grid is clear 2. The question is in accordance with the learning model used 3. The question is in accordance with the indicators to be achieved
Implementation	There are already concerns for students

2) Analysis of Data Results in Practical Problem Based Learning Devices

The main objective of the data analysis of the implementation of the devices resulting from the limited trials is to see the practicality of the device. However, to emphasize more on the implementation of the observation sheet of the device that is used to fulfill reliability empirically, then the calculation of the reliability of the instrument is based on the data from the limited trial results. If the results of reliability calculations conclude that the instrument is not reliable, then the data from the limited trial results are not feasible to use to assess the practicality of the learning device. In order to more easily draw conclusions, the observation data for device implementation is analyzed per component. The results of the analysis for each component are explained below.

3) Analysis of Data Results of the Effectiveness of Learning Devices

In the results of students' responses, students' responses to learning devices are divided into 2 aspects, namely: (1) students' responses to student books, and (2) students' responses to the student worksheet. Based on the results of the analysis of students' responses to student books in limited trials, there were 85% of students who responded positively to student books, and 92.5% of students responded positively to student worksheet, in limited trials students responded positively to learning device.

In the test of learning outcomes of students, to assess the learning outcomes of students in learning used mastery test materials. Based on the data analysis of student learning outcomes in a limited trial in terms of completeness there are 30 students from 35 people (85%) students who score 6.5 and above. Thus the learning outcomes of students are as expected.

On the student activity sheet. Based on the results of the analysis of student activity data in a limited trial, five of the six types of student activities observed were met. Thus according to the activity criteria students are expected to have reached a limited trial.

Discussion

a. The Defining Stage of Conceptual-Conflict-Based Learning Device in Mathematical Problem Solving

At the defining stage it aims to determine the basic problems needed to develop learning devices. At this stage, there were still many students in class X MIA MAN 1 Makassar whose mastery of mathematical concepts was still very low. One of the weaknesses of the students is that they have not been able to

solve the story questions that are required to master good concepts and good principles and skills.

b. The Designing Phase of Conceptual-Conflict-Based Learning Device in Mathematical Problem Solving

At this stage the Lesson Plan, Student Books, Student Worksheets, and Learning Outcomes Test are produced as a solution to the definition phase. The result of the draft of Lesson Plan follows the 2013 curriculum format while the design of the Student Book and Student Worksheet follow the needs of the students in class X at MIA MAN 1 Makassar.

The design of the development of conceptual-conflict-based learning device in mathematical problem solving on the subject of three-variable linear equations is intended to make it easier for students to learn mathematics, especially how to identify a problem, then develop a plan for solving and implementing the solution plan. It starts from recognizing a system of three-variable linear equations, completing the SPLTV set, recognizing a system of three-variable linear equations, completing a system of three-variable linear equations, making a model of a three-variable linear equation system and solving it.

c. Stage of Development of Conceptual-Conflict-Based Learning Device in Mathematical Problem Solving

At this stage a prototype is created, the main design based on the initial design. The prototype made are Lesson Plan, Student Book, Student Worksheet, and Learning Outcome Test. In the first validation of prototype I conceptual-conflict-based learning device in mathematical problem solving were validated by experts and practitioners and were given input to improve the device. The validation results in the first stage have not been declared valid so that revisions still need to be made based on input from the validators and produced prototypes II, then the second stage of validation is carried out which is then declared valid and feasible to use.

In general, it can be said that the learning device developed in this study are learning implementation plans, student books, student activity sheets, and learning outcomes tests can provide a new atmosphere. The following are the differences between student book, student worksheet and the learning outcomes test used by the teacher and those that have been developed, namely:

1) Student Book

Kita lakukan proses eliminasi pada persamaan (1) dan (2), sehingga diperoleh

$$\begin{array}{r} x+y+z = 45 \\ x-y = -4+ \\ \hline 2x+z = 41 \end{array} \dots\dots\dots (4)$$

Kita lakukan proses eliminasi pada persamaan (3) dan (4), sehingga diperoleh

$$\begin{array}{r} x-z = -17 \\ 2x+z = 41+ \\ \hline x = 8 \end{array} \dots\dots\dots (5)$$

Kita lakukan proses substitusikan (5) ke (2) diperoleh

$$8 + 4 = y \Rightarrow y = 12$$

Kita lakukan proses substitusikan (5) ke (3) diperoleh

$$z - 17 = 8 \Rightarrow z = 25$$

Dengan demikian bilangan $x = 8$, bilangan $y = 12$, dan bilangan $z = 25$.

Cara lain yang dapat kamu gunakan selain metode eliminasi, substitusi, dan campuran eliminasi substitusi (kamu coba sendiri) untuk menentukan penyelesaian SPLTV adalah cara determinan, menggunakan invers matriks yang akan kamu pelajari di kelas XI. Sekarang kita akan temukan penyelesaian sistem persamaan linear tiga variabel dengan metode lain.

- Tentukan himpunan penyelesaian *SPLTV* secara umum berdasarkan konsep dan bentuk umum sistem persamaan linear dua variabel yang telah ditemukan dengan mempedomani langkah penyelesaian metode eliminasi di atas untuk menemukan metode Sarrus.

Berdasarkan Definisi 3.4, bentuk umum sistem persamaan linear dengan tiga variabel x, y , dan z adalah


$$\begin{cases} a_1x + b_1y + c_1z = d_1 & \dots\dots\dots (3.3) \\ a_2x + b_2y + c_2z = d_2 & \dots\dots\dots (3.4) \\ a_3x + b_3y + c_3z = d_3 & \dots\dots\dots (3.5) \end{cases}$$

dengan $a_1, a_2, a_3, b_1, b_2, b_3, c_1, c_2, c_3, d_1, d_2, d_3$ dan a_i, b_i, c_i dan d_i bilangan real, dan a_i, b_i, c_i tidak ketiganya 0; a_2, b_2, c_2 tidak ketiganya 0; dan a_3, b_3, c_3 tidak ketiganya 0.

(a)

A Pengertian Sistem Persamaan Linear Tiga Variabel (SPLTV)

Perhatikan masalah kegiatan jual beli berikut ini:



Ibu Ani berjualan ke pasar segar di kota Makassar. Ia membeli tiga jenis buah-buahan yaitu buah apel, buah jeruk dan buah semangka. Jika ia membeli 5 kg buah-buahan. Berapakah kemungkinan banyaknya buah jeruk yang dapat dibeli Ibu Ani?

Perhatikan masalah di atas kemudian jawablah pertanyaan-pertanyaan berikut!

1. Buatlah permasalahan dari masalah tersebut!
2. Tuliskan persamaan linear tiga variabel dari masalah tersebut!
3. Tuliskan variabel dari persamaan yang anda peroleh!

Informasi:
 Secara umum, persamaan linear tiga variabel adalah suatu persamaan yang mempunyai tiga variabel berpangkat satu dan ditulis $ax + by + cz + d = 0$
 Dengan $a \neq 0, b \neq 0, c \neq 0, a, b, c, d \in R$

(b)

Picture 2. Display of Books of Students Used by Teachers (a) and Developed (b)

2) Student Worksheet

Diskusi

Perhatikan ciri penyelesaian untuk x, y , dan z di atas. Coba temukan pola penentuan nilai x, y , dan z . Sehingga memudahkan menentukan penyelesaian SPLTV.

Pada langkah penyelesaian Masalah 3.5 diperoleh sebuah sistem persamaan linear tiga variabel sebagai berikut.

$$\begin{array}{r} x + y + z = 40 & \dots\dots\dots (1) \\ x = 2y & \dots\dots\dots (2) \\ 75 + 120y + 150z = 4.020 & \dots\dots\dots (3) \end{array}$$

Ingat untuk menggunakan semua variabel harus pada ruas kiri, dan semua konstanta berada pada ruas kanan. Untuk itu *SPLTV* di atas diubah menjadi

$$\begin{array}{r} x + y + z = 40 & \dots\dots\dots (1) \\ x - 2y = 0 & \dots\dots\dots (2) \\ 75 + 120y + 150z = 4.020 & \dots\dots\dots (3) \end{array}$$

Tentunya kamu dengan mudah memahami bahwa

$a_1 = 1$	$a_2 = 1$	$a_3 = 75$
$b_1 = 1$	$b_2 = -2$	$b_3 = 120$
$c_1 = 1$	$c_2 = 0$	$c_3 = 150$
$d_1 = 40$	$d_2 = 0$	$d_3 = 4020$

Oleh karena itu, nilai x, y , dan z ditentukan sebagai berikut.

(a)

Lembar Kegiatan Siswa 1

Waktu	30 Menit	Nama	
Tanggal		NIS	
		Kelompok	

Petunjuk:

1. Setelah membaca dan memahami masalah 1 dan 2 pada buku siswa, selesaikan masalah tersebut pada tempat yang disediakan di LKS ini.
2. Perhatikan setiap pemberitahuan pada buku siswa.

Perhatikan kembali masalah 1: Penjualan Pakaian

Ibu Nadha adalah seorang penjual pakaian di Pasar Butung kota Makassar. Ia menjual 2 baju, 1 celana panjang dan celana pendek dengan harga Rp155.000,00, penjualan 1 baju, 2 celana panjang dan 2 buah celana pendek harganya Rp410.000,00. Dan penjualan 2 baju, 3 celana panjang dan 1 buah celana pendek harganya Rp 410.000,00.



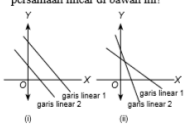
1. Diskusikan secara berkelompok apa yang diidentifikasi dari soal di atas (apa yang diketahui dan apa yang ditanyakan)!
Jawab:
2. Diskusikan bagaimana model matematikanya dari masalah tersebut!
Jawab:

(b)

Picture 3. Display of LKPD used by teachers (a) and Developed (b)

2. Learning Outcomes Test (THB)

Uji Kompetensi 3.3

- Tentukanlah himpunan penyelesaian setiap sistem persamaan linear berikut ini tanpa menggunakan cara aljabar, melainkan melalui metode grafik!
 - $x - y = 3$
 $5x - 3y = 19$
 - $3x - 2y = 1$
 $-x + 5y = 4$
 - $2x - y = 0$
 $7x + 2y = 0$
 - $4x - 12y = 3$
 $12x + 7y = 26$
- Dengan menggunakan kertas berpetak, tentukanlah himpunan penyelesaian melalui grafik setiap sistem persamaan berikut ini!
 - $3x + 2y = 7$
 $x + 3y = 7$
 - $4x + y = 2$
 $3x + 2y = -1$
- Tentukanlah himpunan penyelesaian dari:
 - $4x + 2y = 5$
 $2x + 3y = \frac{15}{2}$
 - $\frac{1}{3}x - \frac{1}{2}y = 1$
 $\frac{1}{2}x + \frac{1}{4}y = -1$
 $\frac{1}{6}$
- Kembali perhatikan sistem persamaan linear dua variabel, $a_1x + b_1y = c_1$, $a_2x + b_2y = c_2$.
Mungkinkah sistem tersebut tidak memiliki himpunan penyelesaian? Jika ya, tentukan syaratnya dan gambarkan!
 - Perhatikan kedua grafik sistem persamaan linear di bawah ini!
 

(a)

Tes Hasil Belajar

Satuan Pendidikan : MAN 1 Makassar
 Kelas/Semester : X/Ganjil
 Mata Pelajaran : Matematika Wajib
 Materi Pokok : Sistem Persamaan Linear Tiga Variabel
 Waktu : 90 Menit

Petunjuk Penyelesaian Soal:

- Kerjakan setiap soal bentuk pada lembar jawaban yang telah disediakan!
- Tulis nama, NIS dan kelas di pojok kanan atas lembar jawaban Anda!
- Dahulukan menjawab soal yang dianggap mudah!

Soal:

- Tuliskan perbedaan antara persamaan linear tiga variabel dengan sistem persamaan linear tiga variabel. Kemudian berikan masing-masing contoh!
- Tentukan himpunan penyelesaian dari sistem persamaan linear tiga variabel berikut dengan menggunakan metode penyelesaian yang Anda ketahui!

$$\begin{cases} x + y - z = 1 \\ 2x + y + z = 11 \\ x + 2y + z = 12 \end{cases}$$
- Diketahui himpunan penyelesaian suatu sistem persamaan linear dua variabel adalah $(2, -1, 4)$. Buatlah paling sedikit dua bentuk sistem persamaan linear tiga variabel dari himpunan penyelesaian tersebut!
- Diketahui uang Amir ditambah dua kali uang Amin lalu dikurangi uang Ani adalah Rp 35.500,- jika dua kali uang Amir dikurangi dua kali uang Amin lalu ditambah uang Ani adalah Rp 84.500,- dan uang Amir ditambah tiga kali uang Amin lalu dikurangi

(b)

Picture 4. THB Display used by Teacher (a) and Developed (b)

Stage Conceptual-Conflict-Based Learning Device in Mathematical Problem Solving

After mathematical learning device based on conceptual conflict in mathematical problem solving on the subject of the three variable linear equations are developed and declared valid and the results of limited and field trials meet the eligibility requirements, it can be concluded that problem-based mathematics learning device which is developed practically and effectively used to develop students' mathematical abilities in problem solving based on conceptual conflict.

CONCLUSION

Learning device that have been developed have met 3 eligibility requirements, namely valid, practical, and effective. In terms of validity, based on the results of the learning device validation, the data obtained that the validation results are divided into two stages, namely the validation stage I and the validation stage II. At the stage of validation I, all learning devices are said to be invalid and not suitable for use. In stage II all the suggestions from the

validator have been corrected and are said to be valid and appropriate to use. In terms of practicality, based on the results of practical testing, it can be said that the learning device is practical based on the results of the implementation. While in terms of effectiveness, based on the results of the trial data obtained effectiveness data that: (1) the average mastery learning obtained by students is 85%. (2) five of the six types of student activities observed have been fulfilled. and (3) and the results of students' responses to learning is positive with 85% of students responding positively to student books and 92.5% of students responding positively to student worksheet. So, it can be concluded that the learning device is effective to be use.

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