DEVELOPMENT OF LEARNING DEVICE BASED CONTEXTUAL TEACHING AND LEARNING BASED ON THE CONTEXT OF ACEH CULTURAL TO IMPROVE MATHEMATICAL REPRESENTATION ABILITY

Azwar[1], Edy Surya[2]

[1] *Student, Post Graduated, Universitas Negeri Medan, Medan, Indonesia*
[2] *Assistent Professor, Universitas Negeri Medan , Medan, Indonesia*
[3] *Professor, Universitas Negeri Medan , Medan, Indonesia*

ABSTRACT

The research is focused: (1) Developed contextual teaching and learning based on the context of Aceh cultural (CTL-BKBA) who meet the effectively used to improve mathematical representation ability of students; and (2) Described the improvement of mathematical representation ability of students using the CTL-BKBA development. Research development of Four-D model was done in two stages: (1) the development of learning devices; and (2) testing devices. The subjects in this study were students of class XI SMAN 1 Peureulak, while the object is the CTL-BKBA developed, mathematical representation ability, of students. The result was obtained: (1) The CTL-BKBA developed effectively used to improve mathematical representation ability of students; (2) There is an increased mathematical representation ability of students using the CTL-BKBA.

Keywords: CTL-BKBA device development, 4-D models, mathematical representation.

1. INTRODUCTION

Mathematics as one of the science that underlies the development of science and technology, so that mathematics is seen as a structured and integrated science, the study of patterns and relationships, and the science of thinking to understand the world around. Cornelius (Abdurrahman, 2012) suggests five reasons for studying math because math is (1) a means to think clearly and logically, (2) the means to solve the problems of everyday life, (3) the means to know the relationship patterns and generalizations experience, (4) the means to develop creativity, and (5) a means to increase awareness of cultural development. But in fact the quality of mathematics education in Indonesia is still low. It is supported by the TIMSS results (The Third International Mathematics Science Study) started in 1999, 2003, 2007, and 2011. Indonesia in 1999 was rated 34 of the 38 countries, 2003 was rated 35 of the 46 countries, and in 2007 was rated 36 of the 49 countries. Meanwhile, in 2011, Indonesia was to rank 38 of the 42 countries with a value of 386 (IEA, 2012). Conditions were not much different can also be seen from the results of studies conducted PISA (Programmed for International Student Assessment), where the results of PISA in 2012 Indonesia

was ranked 64 of the 65 participating countries with an average score of 375, while the average of international score is 500.

The low quality of mathematics education as mentioned above should be fixed. Therefore, mathematics in schools should be able to strive for students to develop the ability to think, reason, communicate ideas and can develop creative and problem-solving activities. This is in accordance with the disclosed NCTM (2000) the standard capabilities that must be achieved in mathematics include problem solving, reasoning and proof, communication, connections and representation. Minarni, et al (2016) finding (1) Based on interview and observation found that conventional approach still uses in all of the class of PJHS, the students engagement in learning activity is very low, and most of the students do not attain minimal mastery achievement. (2) Based on essay test found that performance of the students in mathematical understanding and representation test is categories small.

It is referring to one of the standard process, namely mathematical representation ability is an ability that must be owned by the students. Hasratuddin (2015) says representations are expressions of mathematical ideas shown students as a model or a substitute form of a problem situation that is used to find a solution to the problem at hand as a result of interpretation of mind. Therefore, mathematical representations are ability which is very important for students to understand mathematical problems and solve them in ways that they know and be able to express ideas or mathematical ideas he has in trying to find a solution to the problem at hand.

As one of the process standards NCTM (2000) set the standard representation is expected to be controlled by students for teaching in schools, namely: (1) create and use representations to recognize, record or record, and communicate mathematical ideas; (2) selecting, implementing, and perform translations between mathematical representations to solve problems; (3) use representations to model and interpret physical phenomena, social, and mathematical phenomena.

In fact, from the preliminary findings of researchers by asking questions to measure the ability of mathematical representations on the matter sequence and series to students of SMAN 1 Peureulak found that mathematical representation ability of students is still low, with only 2 students from 25 students or 8% are able to make mathematical model with full completion of the steps and the correct answers with either category, 9 students from 25 students or 36% were able to create a mathematical model with the completion of the steps was not complete and correct answer with enough categories, and 14 students from 25 students or 56 % of students cannot create a mathematical model altogether.

In communicate mathematical ideas and mathematical thinking someone needs to represent these ideas in a certain way. According to Wahyuni (2012) states that a complicated problem would be much simpler if using a representation corresponding to a given problem, otherwise false representation construction makes the problem difficult to solve. Related research is also done by Pujiastuti (2008) showed that most students weak in suggesting ideas or ideas through words or written text.

To develop learning tools that can develop mathematical ability, especially mathematical representation ability through CTL, will be more effective if in the development of learning tools that integrate elements of local culture. Bishop (Tandililing, 2013) says that mathematics is a form of culture. Mathematics as a cultural form, actually has been integrated in all aspects of people's lives wherever they may be. Thus the mathematics of a person affected by their cultural background, because all they do is based on what they see and feel. Culture-Based Learning (ethnos-mathematics) is one alternative that can bridge the culture of mathematics. Pannen (Sutama, et al., 2013) says that a culture based learning strategies learning environment creation and design learning experiences that integrate culture as part of the learning process. Culture is integrated which kinds of cultural context on the ground in Aceh.

The integration of the cultural context of Aceh into the device mathematics learning can provide opportunities for teachers to improve the mathematical representation ability of students as well as introducing multi various cultural context Acehnese close to a child's environment, so that the culture maintained continuity and opportunities for development remain open in the school environment. Interesting develop the contextual teaching and learning in the cultural context of Aceh (CTL-BKBA) is to help students become aware of how students can think mathematically according to their culture and traditions. Therefore, development of the CTL-BKBA is needed to enrich the students' knowledge of mathematics, mathematical improve mathematical representation ability of students, enabling students to face global challenges and also students closer to the cultural environment.

In accordance with the problems that have been described, the purposes of this research are: (1) Developed contextual teaching and learning based on the context of Aceh cultural (CTL-BKBA) who meet the effectively used

to improve mathematical representation ability of students; and (2) Described the improvement of mathematical representation ability of students using the CTL-BKBA development.

2. MATHEMATICAL REPRESENTATION ABILITY

The purpose of learning mathematics has changed not only focus on improving learning outcomes, but also is expected to improve various abilities. One of the mathematical ability students should possess is the ability of representation. The students use these representations to organized and record their thinking about mathematical ideas, for example, they use representations to develop or apply their understanding of proportionality when they make or interpret scale drawings or figures or scale models of objects (NCTM, 2000)

Mathematical representation can be represented into both visual representation and non visual. Visual representation including graph, table, sketch/figure, and diagram; non visual representation including numerical representation, and mathematical equation or mathematical model. The power of representation can be seen clearly whenever visual and numerical representation is used in the problems of ratios, proportions, and percents. The research focus on non-visual mathematical representation.

Students in grade two must familiar with various representation such as drawing physical objects, charts, graphs, symbols, and mathematical models. The students use these representations to organized and record their thinking about mathematical ideas, for example, they use representations to develop or apply their understanding of proportionality when they make or interpret scale drawings or figures or scale models of objects (NCTM, 2000). Without mustering representation, the students will not easy to solve a range of algebra problems, geometric, and linear equation problems due to they cannot easily move from one type of representation to another.

We can find in NCTM (2000) that mathematical representation will enables students to:
(1) Create, and use representation to organize, record, and communicate mathematical ideas; (2) Select, apply, and translate among mathematical representation to solve problems; and
(3) Use representation to model and interpret physical, social, and mathematical phenomena.

3. CONTEXTUAL TEACHING AND LEARNING BASED ON THE CONTEXT OF ACEH CULTURAL

The learning model contextual teaching and learning on the cultural context of Aceh (CTL-BKBA) is a learning model that emphasizes the process of involvement of students in full by applying the cultural context of Aceh to be able to find the material studied and relate them to real life situations that encourage students to apply in real life. According Sinaga (2007) in philosophy, mathematics is the result of the construction of human thought. Therefore, the mathematical result of the reflection of human thinking and problem solving, then mathematics can be said to be the result of human ingenuity and effort. Bishop (Ernest, 1991) asserts that: "Mathematics…is therefore conceived of as a cultural product, which has developed as a result of various activities… Counting… Locating… Measuring… Designing… Playing… Explaining… Mathematics as cultural knowledge, derives from humans engaging in these six universal activities in a sustained and conscious manner".

It is asserted that mathematics is a cultural product developed as a result of various human activities. More Davis & Hersh (Ernest, 1991) reveals that: "Since mathematics is linked with all human knowledge, it is culture-bound and imbued with the values of its makers and their cultural contexts. Consequently, it pervades social and cultural life. This means that a basis for the cultural location of mathematics is needed". Culture largely determines how the student perspective in addressing it, including in understanding a matter of mathematics. This means that when the material is so far from their cultural schemes such material would be difficult to understand. CTL-BKBA model is one alternative that can bridge the culture of mathematics.

The steps of CTL-BKBA learning model is similar to the steps of learning model CTL only in Aceh culture inserted into the syntax of CTL. Meanwhile, Rusman (2012) explains seven principles in the development of contextual teaching and learning. They are: (1) constructivism, (2) inquiry, (3) questioning, (4) learning community, (5) modelling, and (7) authentic assessment.

4. METHODS

This research was the development by using 4-D model of development Thiagarajan, Semmel, and Semmel (1974) it consists of four stages, namely stage define, design, develop and disseminate.

A. Subject and Object

Subjects in this study were students of class XI SMA Negeri 1 Peureulak academic year 2016/2017, where as the object of this research is the CTL-BKBA on the material sequence and series, mathematical representation ability of students. The first trial was conducted in classes XI IPA 1 and a second test is done in class XI IPA 2.

B. Learning Tool Procedure Development

Learning tools developed are: 1) The implementation plan Learning (RPP), Student Book (BS), Student Activity Sheet (LAS), Learning Ability Test (TKB), in particular mathematical representation ability of the student questionnaire. Development of learning devices to use the 4-D model.

C. Instruments and Data Analysis Technique

Instruments and tools for collecting data in this study are the use test, questionnaire and observation sheet. For more details can be seen in Table 1 below.

Table 1. Instruments and Data Analysis Technique

Rated Aspect	**Instruments**	**The Observed Data**	**Respondents**
CTL-BKBA Validity Device	Validation Sheet	RPP validity, BS, LAS, Mathematical Ability Test Representation Questionnaire	Expert/Specialist
Effectiveness of CTL-BKBA Device	Observation Sheet	Improvement of CTL-BKBA Device	Observer
	Test	Mathematical Representation Ability Test	Subject Test
	Observation Sheet	Students Activities	Observer
	Questionnaire	Response of Students	Subject Test

a. CTL-BKBA Validity Analysis Tools

CTL-BKBA device developed in validation by five validator. The criteria for the validity of the CTL-BKBA as follows:

Table 2. Level of Criteria Validity

Va or value of average total	Validity of Criteria
$1 \leq$ V a <2	Invalid
$2 \leq$ Va <3	Less
$3 \leq$ Va < 4	Enough
$4 \leq$ Va < 5	Valid
Va = 5	Best Valid

Source:(Sinaga, 2007)

Annotation:

Va is the level validity of value determination of CTL-BKBA device.

Criteria states CTL-BKBA device has a good degree of validity, if the validity of the minimum level reached is valid level ($4 \leq Va < 5$). If the level of achievement of the validity under valid, it is necessary to revise based on input (correction) experts. Furthermore, the re-validation activities. CTL-BKBA devices that have been revised based on input from experts outside the classroom later tested samples in order to get a decent learning device in order. Then, the test results are analyzed for validity and reliability. The formula used to calculate the validity is the product moment correlation namely:

$$r_{xy} = \frac{n\sum XY - \left(\sum X\right)\left(\sum Y\right)}{\sqrt{\left\{n\sum X^2 - \left(\sum X\right)^2\right\}\left\{n\sum Y^2 - \left(\sum Y\right)^2\right\}}}$$ *(Arikunto, 2012)*

Annotation:

X : score items

Y : total score

r_{XY} : the correlation coefficient between the item score and total score

n : the number of students who take the test (sample)

Then, to determine the coefficient of reliability of a test used in narrative form alpha formula (Arikunto, 2012) as follows:

$$r_{11} = \left(\frac{n}{(n-1)}\right)\left(1 - \frac{\Sigma\sigma_i^2}{\sigma_i^2}\right)$$

Annotation:

r_{11} : reliability coefficient test

n : the number of test items

$\Sigma\sigma_i^2$: the amount of variance test scores of each item

σ_i^2 : the total of variance

b. The Effectiveness of CTL-BKBA Analysis Tool

1. Data Analysis of Improvement of CTL-BKBA Device

The first of Analysis the practicality PBM-BKBA is to use the validation sheet, where all valuators/experts state that the PBM-BKBA device can be used with "minor revision" or "no revision". As for seeing the enforce ability of the device used PBM-BKBA observation sheet improvement learning device. Criteria improvement learning device is as follows:

- Very Low, If $0 \leq \bar{P} < 1$
- Low, If $1 \leq \bar{P} < 2$
- Enough, If $2 \leq \bar{P} < 3$
- High, If $3 \leq \bar{P} < 4$
- Very High, If $4 \leq \bar{P} < 5$

Annotation:

$\bar{P}$ is the average score

CTL-BKBA device is said to be practical or easy to implement if the enforce ability of the CTL-BKBA are in the category of high minimal. As for the reliability of the observation sheet doing, learning device was tested with the following formula, Borich (Herman, 2012):

Percentage of agreement = $\left[1 - \frac{A-B}{A+B}\right]$. 100%

Annotation:
A : Frequency aspects of behavior observed by observers give high frequency
B : Frequency aspects of behavior observed by an observer who provides low frequency

Observation sheet improvement learning device is said to be good if it has a reliability coefficient of 0.75 or 75%, Borich (Herman, 2012:5).

2. *Data Analysis of Mathematical Representation Ability Test*

The first of effectiveness CTL-BKBA based on the achievement of students in the classical mastery learning. The criteria that states students have been able to communicate mathematically if there are 85% of students who took the tests of mathematical representation ability with at least a grade of 75. The percentage can be calculated by the formula:

Percentage of Agreement (R) = $\frac{Agreements\,(A)}{Disagreements\,(D)+Agreements\,(A)} x100\%$

3. Data Analysis of Students Activity

The effectiveness of the CTL-BKBA device are both based on the activities of students meet the tolerance criteria predetermined time. Calculation formula is as follows:

$$Percentage\ of\ Students\ Activities = \frac{The\ Frequency\ of\ every\ aspect\ of\ observationo}{The\ total\ of\ times\ all\ aspect\ of\ observation} \times 100\%$$

Criteria for the effectiveness of student activity based on the achievement of the ideal time applied are as follows:

Table 3. Percentage of Time Ideal for Students Activities

Aspect Catagory	Ideal Time	Tolerance Interval PWI	Kriteria Ideal
1. Listening / paying attention to the teacher's explanations	25% of WT	$20\% \leq PWI \leq 30\%$	Three of 1, 2, 3, 4, 5 achieved and 3, 4 have to achieved
2. Reading Books Student and LAS	15% of WT	$10\% \leq PWI \leq 20\%$	
3. Taking note of the teacher's explanations, notes from books or from friends, solve problems in the LAS, summarizes the work group	30% of WT	$25\% \leq PWI \leq 35\%$	
4. Discussing/ask between student and peers and between student and teacher, concluding a procedure or concept	30% of WT	$25\% \leq PWI \leq 35\%$	
5. Doing something that is irrelevant to learning	0% of WT	$0\% \leq PWI \leq 5\%$	

Annotation:
PWI is the ideal percentage of time
WT is the time available at each meeting

4. Student Response Data Analysis

The effectiveness of the third CTL-BKBA device is based on student responses. Student questionnaire responses were analyzed by using the formula below, Borich (Herman,2012):

$$PRS = \frac{\sum A}{\sum B} \text{ x } 100\%$$

Annotation:
PRS : The percentage of students who leave a lot of positive responses to each category in question.
ΣA : The proportion of students who choose
ΣB : Number of students (respondents)

The criteria are set to say that the students responded positively to the learning media that was developed when the number of students who gave a positive response is greater than or equal to 80% of many subjects in the study for each field tests (Sinaga, 2007).

5. RESULTS

The results of the development of the CTL-BKBA is presented as follows**:**

A. Phase I. Define

1. Front end analysis

Based on the observation of the learning media in senior high school, SMAN 1 Peureulak was found some weaknesses in the learning media used by teachers. Reviewing from the RPP, teachers have not developed of lesson plan that occupy the criteria that have a high validity. Next to the student book (BS), which is used mostly still very general and does not start with a problem but it starts with the concept so that students construct their own knowledge and do not find yourself concept. Then the student book (BS) that is used does not contain a map of concepts, less presents a problem is not routine, does not contain questions contextually related to the diverse cultures that exist in the environment of students as well as the presentation of the questions still lacking in supporting the development of mathematical representation ability, where as LAS untapped at the school. Similarly, the evaluation tool. Teachers designed the evaluation tools without regard to the ability of the indicators to be achieved.

2. Students Analysis

In general, the cognitive development of students of SMAN 1 Peureulak enters the formal operational stage. It is marked on the age of the students of SMAN 1 Peureulak is located in the age range 16-17 years, which if referred to the opinion of Piaget (Trianto, 2009), then the cognitive development of students at that age is the formal operational stage.

3. Concept Analysis

At this stage, the identification of the concept of the subject sequence and series, and then compile them into a form of hierarchy and detailing concepts to the individual in terms of critical and relevant. Analysis of concepts related to the analysis of student material. With the concept maps can be easier for students to understand the subject matter of sequence and series.

4. Task Analysis

Tasks performed by the students in the learning contained in LAS is to find a concept or knowledge, applying concepts /knowledge found them to solve problems in everyday life. Further tasks performed by students in the study contained in the RPP and the Student Book is the same, which is carried out by students independently as an exercise at the end of the learning or used as homework (PR).

5. Formulation of Learning Objectives

Results obtained formulating learning objectives adjusted by the Core Competency (KI) and the Basic Competency (KD), which refers to the curriculum K-13.

B. Phase II. Design

1. Results of Preparation Test

The test was arranged was mathematical representation ability. Tests of mathematical representation ability was structured description consisting of four (4) items,

2. Results of Election Media

Teaching aids used are images embodiment sequence and series in the culture of Aceh, rulers, paperboard, scissors, glue/double tip, pens, pencils, erasers, and LCD.

3. Result of Election Form

The Result of election form in this research adapted to the curriculum K-13. In according to the curriculum K-13, in Learning Implementation Plan (RPP) listed core competition, basic competition, learning indicator, learning objectives, learning materials, learning activities, assessment and learning resources, learning model, method, time allocation, test and answer key and scoring guidelines. The learning activities consist of initial activities, core activities and closing activities. Further to the Student Book Form (BS) refers to the rules of the National Education Standards Agency (National Standards) and form of LAS created in color so that students will be interested and motivated to learn.

4. Results of Preliminary Design

At this stage, produced the preliminary design of the learning media that is Learning Implementation Plan (RPP), Books Students (BS), and Sheet Activities Students (LAS) for 2 (two) time meetings, mathematical representation

ability test, guidance scoring, answer key, and social attitudes questionnaire skill of students. All the results of the design phase are referred draft I.

C. Phase III. Develop

The results of define and design phase produce the preliminary design of a learning media called the draft I. After the CTL-BKBA designed in draft I, then validation tests by experts/specialists (expert review) and field tests conducted.

1. Valuator and Validation Results of Learning Media

Before learning media tested on a trial class, first performed validation by 5 valuators'. The validation of the results can be found in the CTL-BKBA developed is "valid" and can be used with the "some revision". In addition, the research instrument tested on samples outside the classroom is a test of mathematical representation ability also "can be used or valid". To test the reliability of mathematical representation ability of 0.72 (high category)

2. Result of Trial I and Trial II

In trial 1 was conducted in class XI IPA 1 with the number of students 28 students, while in the trial II conducted at the class XI IPA 2 with the number of students 30 students. The results of the test 1 and test 2 are shown in Table 4 below:

Table 4. Result of Trial I and Trial II

Category	**TRIAL 1**		**TRIAL II**	
	The Number of Students	**Percentage**	**The Number of Students**	**Percentage**
Complete	19	67.86%	27	90%
In-complete	9	32.14%	3	10%
Sum	28	100%	30	100%

From Table 4. indicates that, in trial I mastery learning students in the classical test results representation capabilities mathematics that students who passed were 19 students from 25 students or (67.86%) and the number of students who did not complete was 9 students, or (32.14%) of 25 students take the test mathematical representation ability. While in trial II mastery learning students in the classical test results representation capabilities mathematics that students who passed were 27 students from 30 students or (90%) and the number of students who did not complete was 3 students, or (10%) of 25 students take the test mathematical representation ability.

Description of student mathematic communication use CTL-BKBA developed tools at trial I and II are shown in Table 5 below.

Table 5. Description of Mathematical Representation Ability Results

Explanation	**Mathematical Representation**	
	Trial 1 Posttest	**Trial II Posttest**
The highest score	85	97,25
Lowest Rated	50	65
Average	72.33	82.67

Furthermore, Description of student mathematic communication use PBM-BKBA developed tools at trial I and II for each student mathematical communication indicator can be seen in Table 6 below.

Table 6. Average Mathematical Representation Ability of Students for Each Indicator

Indicator of Mathematical Representations	**Average**		
	Trial I	**Trial II**	**Step Up**
Create, and use representation to organize, record, and communicate mathematical ideas;	12.35	13.85	1.50
Select, apply, and translate among mathematical representation to solve problems;	13.28	13.66	0.38
Use representation to model and interpret physical, social, and mathematical phenomena	12.32	13.24	0.92

From the table 5 and table 6 above it can be concluded that the use CTL-BKBA device developed impact on improving representation ability both in terms of the mathematical average of the test results representation ability as well as on each of the indicators mathematical representation ability.

Overall, the results of data analysis trial II showed the CTL-BKBA developed has met all the criteria set forth practical and effective, namely: (1) adherence to the learning device for 2 (two) meetings have reached a very high category and the percentage of the overall reliability of the observation sheet exercise learning device has reached ≥75 (good category); (2) The posttest results of mathematical representation ability have met the criteria of completeness in the classical achievement; (3) students in learning activities have met the ideal time specified; and (4) students response positively to the device components CTL-BKBA developed.

6. DISCUSSION

Based on trial I and trial II results, the PBM-BKBA device developed in compliance with the effective category in terms of: (1) complete learn student in the classical; (2) the activity of students within the tolerance limits specified ideal time; and (3) the students responded positively to the components of CTL-BKBA developed device.

When viewed from the student activity on trial I and trial II showed that, of all aspects of the category of activities the student has met the criteria specified ideal time. so it can be concluded that the activity of students using the CTL-BKBA developed device has met the criteria effective in both trials I and trial II. Description given above shows that at the time of student learning is active and has a high spirit in the following study using the CTL-BKBA. This is in line with the opinion of Arends (2008) which states that the problem based learning model is a model of learning in which students work on authentic problems with a view to construct their own knowledge, and develop independence and confidence.

The results of the average percentage of student responses on each trial is positive. This means that students responded positively to the components of CTL-BKBA developed device. In learning activities, students often have a problematic situation confusing in ascertaining whether the reasons given solution or a solution that is right or wrong. A problematic situation that is confusing or unclear incurred in connection with the cognitive ability of an individual, where the individual is unable to adjust to the situation cognitive structures encountered in learning, then it is said that there is a cognitive conflict within the individual. In accordance with the above results, CTL-BKBA device is based on the premise that the problematic situation that is confusing or unclear will arouse the curiosity of students so as to make them interested to investigate (Arends, 2008:52). Furthermore, PBM-BKBA device developed can arouse students interest in learning, causing learning activities to be effective. This is reinforced by the results of research Sinaga (2007) that shows that students respond positively to the device based on the problem-based learning Batak culture/

7. CONCLUTION

Based on the results of the analysis and discussion in this study, presented some conclusions as follows:

1. Developed contextual teaching and learning based on the context of Aceh cultural (CTL-BKBA) who meet the effectual used to improve mathematical representation ability of students.
   a. The adherence to the CTL-BKBA has reached a very high category as well as the observation sheet enforceability of the CTL-BKBA have achieved good reliability;
   b. The classical mastery learning students has reached 90% in the second test;
   c. The activity of students during activities meet the criteria specified tolerances ideal time; and
   d. Positive student response to the CTL-BKBA device
2. There is increased mathematical representation ability of students using the CTL-BKBA device. The average achievement of students mathematic representation ability of the trial I amounted to 72.33 increased to 10.34 in the trial II.

8. SUGGESTION

In Relation to the conclusions above, some suggestions are offered, namely:

1. Researchers suggest to the reader and education practitioners to be able to conduct similar research, and perform the deployment phase (disseminate) in order to study the resulting device can be applied to school SMA / SMK / MA others.
2. CTL-BKBA device developed can be used as a reference to create a learning device with other materials in order to develop the ability of mathematical representations both at the unit level of education the same or different.

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