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Development of Mathematics Learning Tools by Implementing Numbered Head Together Type Cooperative Models to Improve Students' Mathematical Understanding Ability in Matrix Topic

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A B S T R A C T

Students' mathematical understanding ability in Matrix material of Senior High Schools is still low. This is due to students being less active in learning, teaching materials are still limited and in learning teachers are more accustomed to presenting formulas instantly. This study aims to produce a valid, practical, and effective learning tool by implementing a cooperative model of Numbered Head Together (NHT) to improve students' mathematical understanding abilities in the Matrix Class XI material. The development model used was the Borg and Gall model. Data collection instruments used in this study were interview guides, questionnaires, and tests. The average validation results for RPP is 3.81 and for LKPD is 3.84 with a very valid category. Limited testing of 15 students obtained 91.22% percentage of student responses categorized as very practical. Field trials on 25 students obtained a percentage of the response of students 90.20% categorized as very practical. The results of the effectiveness test indicate that the students' mathematical understanding ability is increasing.

1. Introduction

Learning Mathematics in High School in Curriculum 2013 is not only aimed at students being able to understand and master a variety of mathematical concepts that have been taught, but they must also be able to apply them in solving problems in everyday life. In addition, students are also expected to be able to find various concepts in mathematics through the learning experiences they do. School-based curriculum standards reveal that students must have a set of mathematical competencies that are manifested after the learning process has occurred (Hutapea, 2019). Students' thinking ability must be developed to

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understand mathematics correctly (Heleni et al., 2018). Mathematics is often regarded as a subject that is difficult to understand both in theory and its application (Roza et al., 2017). To achieve the expected learning objectives, it is not an easy matter, but there are many obstacles encountered, especially at SMAN 2 Rumbiojaya, namely the use of memorizing the formula system to solve mathematical problems which results in students being able to use it only without knowing its origin, learning is carried out still much focused on the teacher, students look less active and less enthusiastic in participating in learning activities in class.

Based on the results of the researchers' interviews with 3 mathematics teachers in class XI of SMAN 2 Rumbiojaya, problems were found: (1) students had difficulty understanding matrix material; (2) the teacher has difficulty teaching matrix material with conventional learning. Based on observations obtained information that Mathematics teaching materials for students who use the 2013 curriculum are still limited, that is only using the master book that has been provided by the Ministry of Education and Culture and the amount is still limited. In the learning process many students use teaching materials in the form of books used in the education unit level curriculum (KTSP) in which the dominant formula presents without giving the opportunity for students to build understanding of a mathematical concept. This is what causes students to feel difficulty when learning and applying a mathematical concept because they only use instant formulas without knowing their origin.

According to the results of interviews with 25 students of class XI SMAN 2 Rumbiojaya, obtained information that most students consider the matrix material described by the teacher is difficult for them to understand. When the teacher gives practice questions about the multiplication operation of two matrices with different orders from the example described by the teacher, the students already find it difficult to determine which elements should be multiplied. This shows that the conventional learning process that has been used is less effective and does not meet the needs of students. Most schools do not teach students to think critically or solve problems. Worksheets contain facts that require students to remember only, so the evaluation ability test is limited to memorization (Yennita et al., 2018). To learn mathematics optimally, the teacher's function as a good facilitator is needed (Marsigit, 2011). Referring to this opinion, it can be seen that the teacher as a facilitator needs to develop learning tools with the right approach to meet the needs of students.

The matrix is one of the materials that is very close to the daily problems of students, especially for high school students. Matrix has many benefits in daily life, such as being used to solve various mathematical problems, for example in finding solutions to linear equation problems, besides the matrix also makes it easy to make an analysis of an economic problem containing various variables, the matrix is also associated with the use of input analysis output both in economics, statistics, and in the fields of education, management, chemistry, and other fields of technology. However, the reality on the ground shows that learning activities often encounter difficulties in learning matrices. This is because teachers

are more accustomed to presenting formulas in an instant, so matrix learning becomes less interesting and difficult for students to understand. In addition, teachers also have difficulty in presenting contextual problems in the matrix that are easily understood and imagined by students to help students in understanding the concept of the matrix, the teacher should be able to find solutions so as to improve students' mathematical understanding ability in solving given problems .

Santrock (2008) in Utari, et al., (2017) stated that the ability of mathematical understanding is very important and must be possessed by students in learning mathematics, the ability is an important basis for thinking in solving mathematical problems and real life problems. Someone who has mathematical understanding ability means that the person already knows what he has learned, the steps that have been done, and can use concepts in a mathematical context or outside the mathematical context. Mathematical understanding is an important basis for thinking in solving mathematical problems and real life problems. Raharjo (2014) and others (Rahmi, 2017; Fendi et al., 2019) explains that the factors that cause the low ability of students' mathematical understanding are the low quality of mathematics learning and the dominant use of conventional learning, namely learning that emphasizes mastery of procedures and algorithms.

According to Marsuha in Andri (2019), the essence of cooperative learning is the positive development and interdependence of group members. In accordance with the characteristics of students, the learning model applied is cooperative learning type NHT, which is a form of learning model that gives students an opportunity to discuss with their friends in solving mathematical problems, utilizing the tendency of students to interact more in learning to achieve learning objectives. Through the process of calling random numbers, it will make students feel more responsible (Lis, 2014). NHT type of cooperative learning model allows interaction between the teacher and students as well as between students and students. In this case students are divided into small groups that are heterogeneous, consisting of students who have high, medium and low abilities. Thus the questions given by the teacher are the responsibility of each group member, students who have high ability are responsible for explaining to their low-ability friends, they can learn with their peers in the group. NHT type of cooperative learning model allows students to be more active and have a great sense of responsibility, the development of creative power, can optimally meet the needs of students, so that they can improve students' mathematical understanding abilities. The purpose of this study is to produce learning tools in the form of RPP and LKPD by applying the Numbered Head Together cooperative learning model to improve students' mathematical understanding abilities on the subject matter of Class XI Matrix which is valid, practical, and effective.

2. Methodology

In this study, a set of learning tool consisting of RPP and LKPD was used together with the Numbered Head Together (NHT) type of cooperative learning model to improve students' mathematical understanding abilities on the subject matter of Class

XI Matrix. The tools were then tested for the validity, practicality, and effectiveness of the product. The model and procedure of developing learning tools used in this study were adapted from the development design model developed by Borg and Gall in (Sugiyono, 2015). The design of this development consists of ten steps, namely:

(1) research and data collection. At this stage the researcher conducted a needs analysis which includes analysis of learning tools, material analysis, and student analysis. In the analysis of learning tools, researchers analyzed problems related to mathematics learning devices used by teachers in schools. Information search was conducted by researchers by conducting interviews and study documents about the learning tools used by teachers in schools. Based on the problems that arise in the field, then a solution was made in the form of a learning device design, which is a syllabus, lesson plan, and LKPD based on curriculum analysis and existing theories. In the material analysis, a matrix was given for odd semester XI students. Based on the analysis of Basic Competence (KD), the learning material consists of finding the concept of matrices and types of matrices, the similarity of two matrices and transpose matrices, addition operations and subtraction matrices, multiplication operations of a real number with matrices and multiplication operations of two matrices and their properties. Student analysis is a study of the characteristics of students, abilities, and experiences of students in schools that will be used as a reference in determining the appropriate models, methods, and learning strategies. Analysis of the characteristics of learners aims to find out various characteristics of students so that researchers can develop learning tools that are appropriate to the characteristics of students. Characteristics of students related to the level of intelligence, learning styles, and learning habits of students. In the analysis of students the researchers analyzed the characteristics of students which include the level of intelligence and study habits;

(2) planning, namely reviewing the material to be arranged in the learning kit, the steps taken include formulating specific learning objectives, determining learning material, strategies, media used, evaluation and sources, making a validation sheet, compiling a validation sheet learning, and composing instruments of mathematical understanding ability;

(3) development of learning tools, namely researchers make learning devices that have been previously designed consisting of Syllabus and RPP, LKPD;

(4) limited trial, which is a valid learning tool which is then tested on 15 students of Class XI IPA of SMAN 2 Rumbiojaya. Students are asked to work on LKPD that has been developed, then fill in a questionnaire of responses aimed at assessing the readability of the LKPD;

(5) product revision, that is LKPD is revised in accordance with the results obtained in a limited trial. Product revision is done by analyzing deficiencies found in limited trials;

(6) field trials, namely the revised learning kit which is then tested on 25 students of Class XI IPA of SMAN 2 Rumbiojaya. Field trials aim to assess the practicality and

effectiveness of learning devices on a larger scale. To assess the practicality of the learning device is done by analyzing students' response questionnaires, and to assess the effectiveness of the learning device by providing KPM test questions, then analyzing the KPM test results of the students;

(7) product revision, i.e. the learning device is revised according to the results obtained in the field trial. Product revision is done by analyzing deficiencies found in field trials;

(8) dissemination, conducted in a seminar on the results and preparation of articles for publication in a journal. In the research and development carried out, researchers limit the research steps, namely the 8th step of operational field testing and the 9th step of revision of the final product is not carried out.

3. Results and Discussion

This development research was carried out by establishing the basic problems faced in the implementation of the 2013 Curriculum, especially at SMAN 2 Rumbiojaya so that a solution was needed for this problem. The problem faced was that students have difficulty in understanding matrix material and teachers have difficulty teaching matrix material with conventional learning. Based on observations obtained information that Mathematics teaching materials for students who use the 2013 curriculum are still limited, that is only using a master book that has been provided by the Ministry of Education and Culture and the number is still limited. In the learning process, many students use teaching materials in the form of books used in the educational unit level curriculum (KTSP) in which the dominant formula presents without giving an opportunity for students to build understanding of a mathematical concept. This is what causes students to feel difficulties when learning and applying a mathematical concept because they only use instant formulas without knowing their origin. Students are less active in learning and feel ashamed to ask the teacher about material that is less understood. Because students have different abilities, the consideration in developing RPP and LKPD is that the device can be used by students with high, medium, or low abilities. Furthermore, the activities carried out in this step are to determine the content of teaching materials in broad outline of Basic Competence (KD), analyze the main concepts of the material developed and formulate indicators and learning objectives based on the KD that have been determined.

At the planning stage, the development activities undertaken were designing or designing learning tools namely RPP and LKPD based on the 2013 curriculum on matrix material by applying the cooperative learning model type Numbered Head Together (NHT). The development of RPP was adjusted to the steps of cooperative learning with the Numbered Head Together (NHT) type. The compilation and systematic of the RPP that was developed was guided by Permendikbud No. 22 of 2016. The developed LKPD contained steps to find concepts and solve matrix problems so that students could be active in learning activities and meet deductive, constructive, and technical requirements.

Furthermore, researchers compile validation sheets and student questionnaire responses.

At the development stage of learning tools, the development activities undertaken are making learning tools (RPP and LKPD) that are in accordance with the initial design. The developed lesson plan was then validated by two Mathematics Education lecturers of Universitas Riau and a mathematics teacher at SMAN 2 Rumbiojaya. The RPP and LKPD were then revised according to the validator's suggestion. After a revision and analysis of the validation results, the RPP and LKPD obtained with very valid values for each aspect. Furthermore LKPD was tested in small groups to see readability and large group testing to see practicality. The results of the RPP and LKPD validation can be seen in Figure 1.

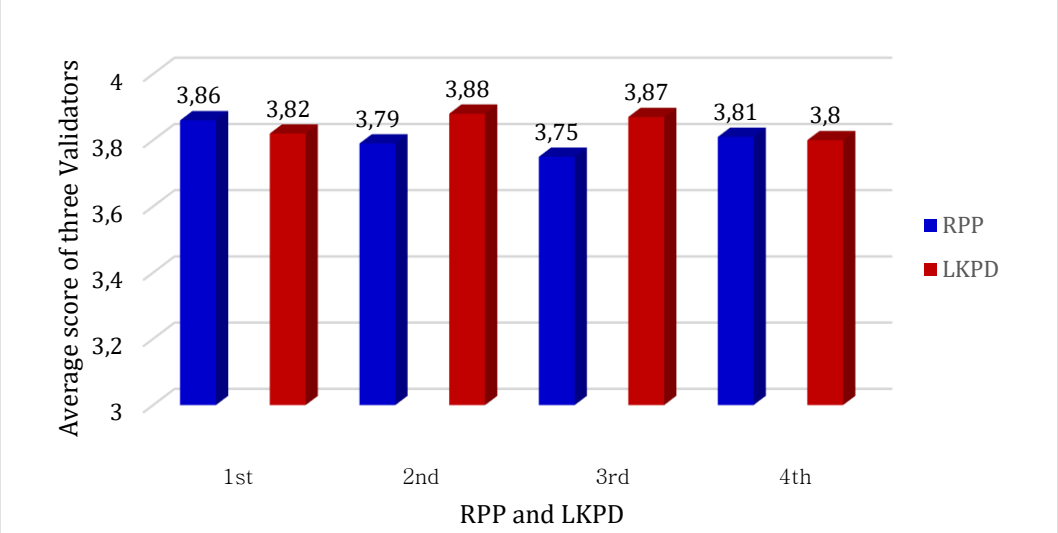

Figure 1. RPP and LKPD Validation Results

Figure 1 shows the average score of the 3 validators for RPP and LKPD that are 3.81 and 3.84, respectively. Thus the results of the validation of the RPP and LKPD are declared very valid. While, the results of data collection about students' responses to LKPD in small group trials can be seen in Figure 2.

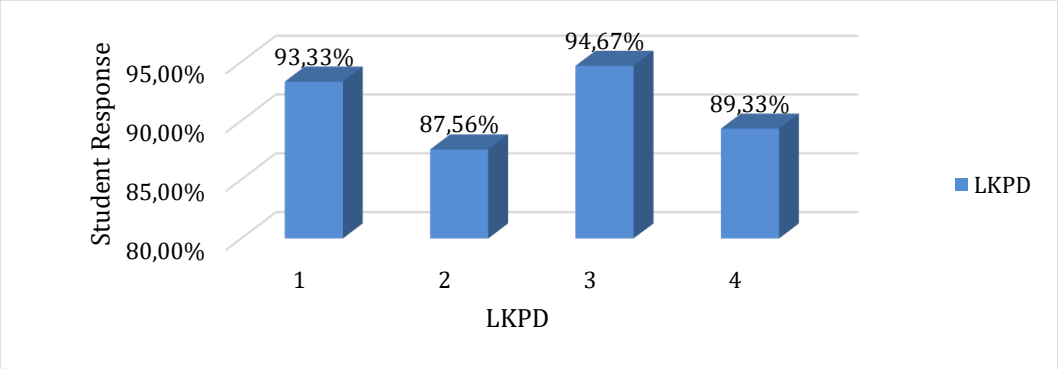

Figure 2. Student Response Results in Small Group Trials Against LKPD

From Figure 2, it can be seen that the best response of students is for LKPD 3, students state that they can carry out activities in LKPD well, instructions for activities are clear, sentences in LKPD are not too long and easy to understand, the composition of colors in LKPD is interesting, and the presentation LKPD makes them interested in learning the matrix material, with exercises the questions in LKPD make them better understand the material provided and the questions contained in LKPD in accordance with the material being studied, they like to study with LKPD because the pictures are good and interesting according to the problems given , they do not find it difficult to solve problems in the addition and subtraction matrix operations using LKPD, learning by using LKPD fosters their curiosity about the matrix material, trains them to find the concept of the matrix because all information is not directly available in LKPD, and the activities contained at L KPD trains them to be more careful in carrying out everything. Based on the results of the questionnaire responses of students in small group trials, the LKPD cooperative learning model Numbered Head Together (NHT) to improve students' mathematical understanding ability can be categorized very practical with an average value of 91.22%. The results of data collection about students' responses to LKPD in large group trials can be seen in Figure 3.

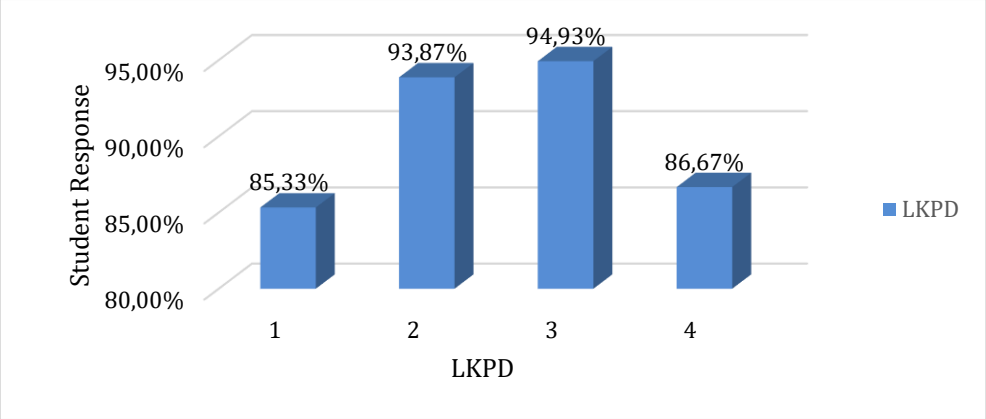

Figure 3. Student Response Results in Large Group Trials Against LKPD

From Figure 3 it can be seen that the best student responses are for LKPD 3, students state that they can carry out activities in LKPD well, instructions for activities are clear, sentences in LKPD are not too long and easy to understand, the color composition in LKPD is interesting, and the presentation LKPD makes them interested in learning the matrix material, with exercises the questions in LKPD make them better understand the material provided and the questions contained in LKPD in accordance with the material being studied, they like to study with LKPD because the pictures are good and interesting according to the problems given , they do not find it difficult to solve problems in the addition and subtraction matrix operations using LKPD, learning by using LKPD fosters their curiosity about the matrix material, trains them to find the concept of the matrix because all information is not directly available in LKPD, and the activities contained at L KPD trains them to be more careful in carrying out everything. Based on students 'response questionnaire data in large group trials, the LKPD of

the Numbered Head Together (NHT) cooperative learning model to improve students' mathematical understanding abilities can be categorized very practical with an average value of 90.20%

The effectiveness of the learning tools developed was obtained from a mathematical understanding ability test (KPM), that is by looking at the achievement of the KPM aspects of each indicator. The learning kit was tested on 25 students of Class XI IPA of SMAN 2 Rumbiojaya. KPM test results can be seen in Figure 4.

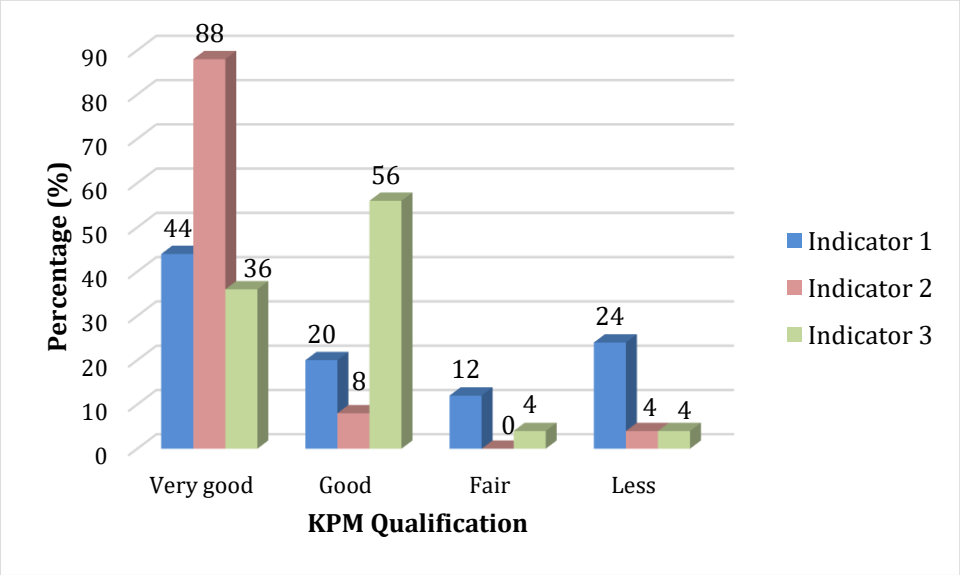

Figure 4. Percentage of Students Based on KPM Qualifications for Each Indicator

Based on KPM qualifications obtained by students in each indicator, it can be seen the percentage of students based on KPM qualifications classically in Figure 5.

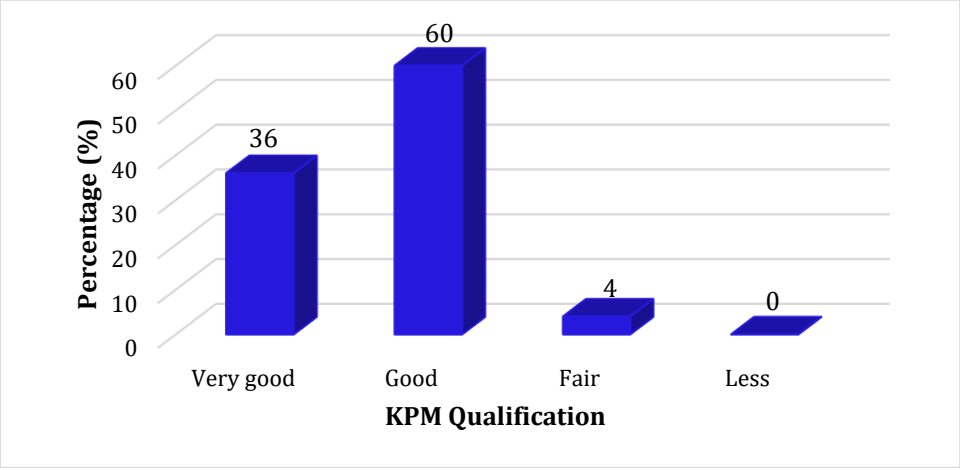

Figure 5. Percentage of Students Based on KPM Qualifications

In figure 5, it shows that KPM qualifications are very good and good, there are 96% of all students. It means that the learning tools developed using the Numbered Head Together (NHT) type of cooperative learning model are effective to improve students' mathematical understanding abilities on the subject matter of Class XI Matrix. Based on the results of the study, it can be seen the percentage of KPM qualifications of students in each indicator. In indicator 1, students who have very good qualifications are 44%, good qualifications are 20%, enough qualifications are 12%, and qualifications are less than 24%, so it is said students can restate the concepts that have been learned appropriately. In indicator 2, students who have very good qualifications are 88%, good qualifications are 8%, and qualifications are less than 4%, it is said students can provide examples and not examples of concepts that have been learned appropriately. For indicator 3, students who have very good qualifications are 36%, good qualifications are 56%, qualifications are 4% enough, and qualifications are less than 4%, students are said to be able to apply the concept algorithmically. This shows that the cooperative learning model type Numbered Head Together (NHT) is effective for improving students' mathematical understanding abilities on the subject matter of Class XI Matrix.

The NHT type of cooperative learning model is a form of learning model that gives students the opportunity to discuss with their friends in solving mathematical problems, utilizing students' tendencies to interact more in learning to achieve learning goals. Through the process of calling random numbers, it will make students feel more responsible. NHT type cooperative learning model is a learning model that can make students to be more active and take full responsibility in understanding learning material, both in groups and individually, and requires students to be involved in teaching and learning in class (Susanto & Armis, 2017).

Sumarmo in (Depi, 2016) stated that the ability of mathematical understanding is very important and must be owned by students in learning mathematics, this ability is an important basis for thinking in solving mathematical problems and real life problems. Someone who has mathematical understanding ability means that the person already knows what he has learned, the steps that have been done, and can use concepts in a mathematical context or outside the mathematical context. The ability of mathematical understanding is a very important ability in learning mathematics. Without an understanding of the basic concepts that are strong for students, students will not be able to understand the concepts given.

However, the ability to understand the concept of students at this time is not in accordance with curriculum expectations, where understanding the concept is the main focus in learning mathematics. (Andi et al., 2016) stated that the ability of mathematical understanding is one of the important goals in learning, providing an understanding that the material taught to students is not just memorization, but more than that with understanding students can better understand the concept of subject matter itself.

Based on the results of the validation of the RPP and LKPD, the results of the questionnaire responses of students to LKPD mathematics on the matrix material, and the results of the students' mathematical understanding ability test, it can be concluded that the RPP and LKPD developed are valid, meet practical requirements, and are effective for students to use. grade XI students. The weakness of the research and development carried out is that researchers limit the research steps, namely the 8^{th} step of operational field testing and the 9^{th} step of revision of the final product is not done, because in SMAN 2 Rumbiojaya class XI IPA TP. 2018/2019 only consists of one class, so research is only conducted in one class.

4. Conclusion

This development research resulted in a product in the form of learning tools using the Numbered Head Together (NHT) cooperative learning model to improve students' mathematical understanding abilities on the subject matter of Class XI Matrix. This mathematics learning tool has been through validation and two trials, namely limited trials and field trials. Based on the analysis of the results of the validation of the RPP and LKPD by the validator, the average validation results obtained for the RPP is categorized very valid, and for LKPD is categorized very valid. So, it can be concluded that learning tools developed using the Numbered Head Together (NHT) cooperative learning model to improve students' mathematical understanding abilities on the subject matter of Class XI Matrix have been assessed as valid, practical, and effective, getting excellent responses from students.

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