**Jurnal Pendidikan Matematika (Kudus)**

P-ISSN 2615-3939 | E-ISSN 2723-1186

https://journal.iainkudus.ac.id/index.php/jmtk

DOI: -

Volume xx, Nomor x, Juni xxxx, hal. x-xx

The Development of STAD Type Cooperative learning toolss To Improve Student Learning Outcomes On The Topic Of Sequences and Series

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Abstrak

Penelitian ini bertujuan untuk menghasilkan perangkat pembelajaran kooperatif tipe STAD yang dapat meningkatkan hasil belajar siswa kelas XII pada topik barisan dan deret. Jenis penelitian ini merupakan penelitian eksperimen semu. Penelitian ini dilaksanakan dalam dua tahap, yaitu tahap pengembangan perangkat dan tahap eksperimen. Hasil penelitian menunjukkan bahwa: (1) perangkat pembelajaran kooperatif tipe STAD yang dikembangkan telah memenuhi kriteria perangkat pembelajaran yang baik karena dinyatakan valid oleh para validator, dan pada tahap ujicoba diperoleh kemampuan guru dalam mengelola pembelajaran berkategori baik, aktivitas siswa berkategori efektif, respons siswa positif, dan lebih dari 75% siswa mencapai ketuntasan belajar, serta THB valid, reliabel dan sensitif; (2) pembelajaran kooperatif tipe STAD efektif untuk mengajarkan topik barisan dan deret pada siswa kelas XII karena 83,87% siswa mengalami ketuntasan belajar, kemampuan guru dalam mengelola pembelajaran berkategori baik, aktivitas siswa berkategori efektif, dan respons siswa positif; (3) hasil belajar siswa kelas XII pada topik barisan dan deret yang diajar dengan pembelajaran kooperatif tipe STAD lebih baik secara signifikan daripada hasil belajar siswa yang diajar dengan pembelajaran konvensional. Dengan demikian, dapat disimpulkan bahwa perangkat pembelajaran kooperatif tipe STAD yang dihasilkan dapat meningkatkan hasil belajar siswa kelas XII pada topik barisan dan deret.

**Kata kunci**: Pembelajaran Kooperatif tipe STAD, Hasil Belajar, Barisan dan Deret

Abstract

**The Development of STAD Type Cooperative learning toolss To Improve Student Learning Outcomes On The Topic Of Sequences and Series**.This study aims to produce a STAD-type cooperative learning tool that can improve student learning outcomes in class XII on sequences and series. This type of research is quasi-experimental research. This research was carried out in two stages: the device development and experimental stages. The results showed that: (1) the STAD type cooperative learning tool developed had met the criteria for a good learning tool because it was declared valid by the validators. At the trial stage, the teacher's learning ability was considered good; student activity was categorized as effective, student responses were positive, and more than 75% of students achieved complete learning, and THB was valid, reliable, and sensitive; (2) STAD type cooperative learning is effective for teaching the topic of sequences and series to class XII students because 83.87% of students experience learning mastery, the teacher's ability to manage to understand is categorized as good, student activities are classified as effective, and student responses are positive; (3) the learning outcomes of class XII students on the topic of sequences and series taught by cooperative learning type STAD were significantly better than the learning outcomes of students taught by conventional learning. Thus, it can be concluded that the STAD type cooperative learning device produced can improve the learning outcomes of class XII students on the topic of sequences and series.

**Keywords**: STAD Cooperative Learning type, Learning Outcomes, Sequences and Series

Introduction

Whether we realize it or not, mathematics is a very important subject, because mathematics is the basis of all science and technology in this world. The rapid development in the field of modern science today can't be separated from the development of mathematics in various fields. Soedjadi [1999] states that mathematics as one of the basic sciences, both its applied aspects and its reasoning aspects, has an important role in the effort to master science and technology. As a basic science, mathematics can be applied in various disciplines. Therefore, to a certain extent mathematics needs to be mastered by all Indonesian citizens, both in its application and in its mindset.

Mathematics plays a very important role in daily life. Many daily problems can be solved using mathematical concepts. Therefore, mastery of mathematics is very important for students as a provision to deal with increasingly complex life problems in the future. Mastery of mathematics is not the ability to count quickly or memorize various formulas and procedures in solving problems, but the ability to think mathematically and use them in problem-solving. Thinking mathematically will support science, technology, economic life, and economic development. Thinking mathematically in a broad context is important because it is the same as equipping students with the skills to use mathematics

To be able to achieve the expected learning objectives, a collaboration between students and educators who interact educatively with one another is required. Students (students) are expected to have great motivation and enthusiasm in learning mathematics. Meanwhile, educators (teachers) are expected to be able to teach mathematics professionally by applying active, creative, varied, and fun learning methods. However, in reality, many mathematics lessons are still carried out in a monotone and tedious manner. Learning always starts from the stage of presenting the material, definitions, and formulas, followed by giving examples of questions and ending with practice questions. Student enthusiasm in this learning can occur when the teacher can show mathematical abilities in front of students, is able to count and solve problems with quick tricks. Of course, this kind of enthusiasm of students is not something that is expected because learning mathematics should provide a condition that allows students to actively construct their knowledge and think creatively in solving problems.

According to Isjoni [2013], learning is an educator's effort to help students carry out learning activities. Learning objectives are the realization of the efficiency and effectiveness of learning activities carried out by students. In line with this, Mulyasa [2010] states that teachers must provide easy learning for all students, in order to develop their potential optimally. In this case, the teacher must position himself as a facilitator who is always ready to provide convenience, serving students according to their interests, abilities, and talents. To meet these demands, teachers must maximize learning, and make learning a place for building competencies and improving the personal quality of students.

Taking into account the matters mentioned above, teachers should always consider the use and selection of appropriate methods in learning mathematics. Teachers are required to know variations in learning methods and be able to use them according to the conditions and learning objectives. At present, there are so many kinds of strategies or learning methods that aim to improve the quality of learning mathematics for the better. One method that has been widely applied currently is cooperative learning. According to Isjoni [1999], cooperative learning is learning that uses small groups so that students work together to achieve learning goals. Students in cooperative groups discuss with each other, help each other, and invite each other to solve learning problems. With cooperative learning, the teacher can condition students to be active and provide mutual support in group work to solve problem material in the learning.

The theory that underlies cooperative learning is constructivism theory. Rusman [2012] states that basically, the constructivism approach to learning is an approach where students must individually find and transform complex information, examine the information with existing rules and revise it if necessary. Cooperative learning encourages students to interact actively and positively in groups. This allows for the exchange of ideas and the examination of one's own ideas in an atmosphere that is not threatened, in accordance with the philosophy of constructivism. Thus, education should be able to condition and provide encouragement to be able to optimize and generate student potential, foster activity, and creativity (creativity), so as to ensure dynamics in the learning process.

In conventional learning, the teacher acts as the main source of information for students. The teacher actively explains the material being taught, while students record all the information written and explained by the teacher. Specifically, Hudojo [1998] states that conventional mathematics learning which is the habit of teachers is learning which presents a sequence: (1) given definitions and formulas, (2) given examples, and (3) given question exercises. Therefore, the learning that occurs is not student-centered, but teacher-centered. In this kind of learning, usually only certain students are the focus of the teacher's attention, namely students who have good mathematical abilities, can actively and confidently participate in learning. Meanwhile, other students are only passive listeners, they do not have the courage to ask questions or express their ideas. Their existence seems neglected. Cooperative learning is expected to accommodate various kinds of characteristics and abilities of students. Students are grouped into heterogeneous groups mainly based on their academic abilities. Sanjaya [2014] suggests several reasons for preferring heterogeneous groupings. First, heterogeneous groups provide opportunities to teach and support each other. Second, heterogeneous groups facilitate classroom management because with one high academic ability the teacher gets one assistant for every three people. Thus, through cooperative learning, students are encouraged to exchange information and opinions, discuss problems together, compare their answers, and correct things that are not quite right.

In a study conducted by Amir Mahmud *et al* [2012] on 306 Grade VII students of State Junior High Schools throughout Cilacap Regency in the 2010/2011 academic year, it concluded that the STAD type of cooperative learning method can improve student achievement better than the method. conventional. In another study conducted in Malaysia, Effandi Zakaria *et al* [2010] using the control class and the experimental class also concluded that cooperative learning type STAD can improve student achievement and positive attitudes towards mathematics. The conclusion of this study also recommends that mathematics teachers use cooperative learning models regularly and effectively in order to obtain maximum learning outcomes. In addition, Eminingsih's research [2013] entitled, "Improving Mathematics Learning Outcomes Through Cooperative Learning Type STAD in Class VII E Students of SMP Negeri Batang" also gave similar results, namely cooperative learning increases student achievement and students' positive attitudes towards mathematics.

The two studies mentioned above are evidence that the STAD type of cooperative learning method can have a positive impact on learning mathematics in the classroom and is able to further activate students in learning. Students are directly involved in constructing their own knowledge so that better understanding and learning outcomes of mathematics can be expected.

One of the mathematics topics taught in class XII at the SMK level is sequences and series. Sequences and series are some of the mathematical topics in which there are many concepts that can be applied in everyday life. These concepts should be well understood by students and not just memorized. Memorization without a strong understanding of concepts will cause students to quickly forget and be less able to solve broader questions, let alone be able to apply these concepts in everyday life. In order for these concepts to be well understood by students, students must be actively involved in learning. Students are expected to actively construct their understanding through group discussions and the exchange of opinions with the teacher and with their group friends. One method that can be taken to activate students in learning is the STAD type cooperative learning method. This is because, if students are involved in learning through discussions between students and discussions with teachers, it is hoped that students' understanding will be better, and will be able to apply their understanding to other contexts, especially in daily life. Slavin [1995] states that in the STAD type of cooperative learning, students are divided into learning teams consisting of four people with different levels of ability, gender, and ethnic background. The teacher delivers the lesson, then students work in teams to ensure that all team members have mastered the lesson. Furthermore, all students take quizzes about the material independently, at which time they are not allowed to help each other.

To be able to apply mathematics learning through cooperative learning type STAD, learning tools are needed in accordance with this method. Learning equipment is a very important factor to support the smooth teaching and learning process. In order for the learning process to run well and achieve learning objectives, a good learning tools is needed as well. From the description above, the researcher considers it necessary to develop STAD type cooperative learning tools on the topic of sequences and series.

Methods

This research can be classified as experimental research which is preceded by development research because in this study the STAD type cooperative learning tools development process was carried out on the topic of sequences and series. Furthermore, by using a learning tools that has been developed and that meets the criteria for a good learning tools, experimental research is carried out. Experimental research aims to determine the effectiveness of cooperative learning type STAD and to compare the learning outcomes of students taught using cooperative learning type STAD with students taught using conventional learning. The learning tools development procedure used in this study refers to Plomp's [11] development model. This model consists of 5 development phases, namely: (1) the initial investigation phase, (2) the design phase, (3) the realization phase, (4) the test, evaluation, and revision phase, and (5) the implementation phase.

To get a good learning tool, a trial of the learning tools that has been developed is carried out. The test subjects of the learning tools were students of class XII PB at SMK NU 1 Karanggeneng Lamongan in the 2015/2016 academic year. The trial design used the One Group Pretest - Post Test Design design. This model uses two times data collection (pretest and post test). This trial design can be described as follows:

Table 1 learning tools Trial Design

|  |  |  |  |
| --- | --- | --- | --- |
| Class | Pretest | Treatment | Post Test |
| Trial | T1 | X | T2 |

Information:

T1 = Pretest is used to determine the students' ability before joining the lesson

T2 = Posttest is used to determine students' ability after participating in the lesson

X = treatment, namely the implementation of learning cooperative type STAD

T1 = T2 (Pretest questions are the same as post test questions)

The research instrument developed was a validation sheet for learning toolss, an observation sheet for the teacher's ability to manage learning, a sheet for field notes to observe student activities, a student response questionnaire, and a learning outcome test. Learning tools developed are said to be of good quality if they meet valid, practical, and effective criteria (Nieveen, 1999). Valid, if: (1) The validator provides a general assessment that the tools developed, including lesson plans, worksheets, and THB are at least good (valid), (2) the knowledge assessment sheet (Learning Outcomes Test) meets the valid, reliable, and sensitive criteria. Practically, if the learning tools can be used by teachers and students, this is indicated by (1) The results of the observation of the teacher's ability to manage learning, namely the assessment score of each aspect observed in each meeting has a good enough minimum category, (2) Student activities in learning are categorized as effective. Effective, if: (1) Student responses to positive learning, that is, at least 80% of students give positive responses, (2) Students achieve completeness of classical learning outcomes, namely at least 75% of students score ≥ 75 adjusted to the KKM score.

Furthermore, to determine the effectiveness of cooperative learning type STAD and to compare the learning outcomes of students taught using cooperative learning type STAD with students taught using conventional learning, the implementation of type STAD learning tools is carried out. The subjects of the implementation of the learning tools were students of class XII AK as the experimental class and class XII PM as the control class. The two classes come from the same school, namely SMK NU 1 Karanggeneng Lamongan in the 2015/2016 academic year.

The experimental design used at the experimental stage was a two-group pretest-posttest design as shown in the following table.

Tabel 2 learning tools Experiment Design

|  |  |  |  |
| --- | --- | --- | --- |
| Group | Pretest | Treatment | Post test |
| Experiment | T1 | X | T2 |
| Control | T1 | Y | T2 |

Information:

T1 = pretest value of the experimental group and group control

T2 = post test value of the experimental group and group control

X = Application of type STAD cooperative learning

Y = Application of conventional learning

T1 = T2 (questions used for pretest and post test is the same problem, which is about THB)

The data analysis technique used to determine the effectiveness of STAD-type cooperative learning in the experimental class was descriptive statistical analysis.

a. Data analysis of the results of the validation of learning toolss

The data from the experts' assessment for each learning tools were analyzed by considering input, comments, and suggestions from the validator. The results of the analysis are used as a guide for revising learning tools.

b. Analysis of student activity data

Student activities are said to be effective if the results of field notes show student activities during learning activities in accordance with student activities that are expected to appear in cooperative learning type STAD.

c. Data analysis on the ability of teachers to manage learning

The teacher's ability to manage learning is said to be good if the score from each aspect that is assessed is at the minimum criteria is good enough.

d. Analysis of student response data

Student responses are said to be positive if the answers of students who choose the positive category for each aspect responded to get a percentage of ≥ 80%.

e. Data analysis of learning outcomes

Analysis of student learning outcomes data descriptively aims to describe the completeness of student learning outcomes based on tests carried out by a student who is said to have completed learning individually if the score obtained by the student is at least 75 from a maximum score of 100. While classical learning completeness is achieved if the class is more than or equal to 75% of students complete their studies.

STAD-type Cooperative Learning on the topic sequence and series is effective if the following conditions are met, namely:

1. Classical learning outcomes are complete.
2. The teacher's ability to manage learning is at least good.
3. Effective student activity
4. Positive student response

Before the t-test is carried out, the sample homogeneity test is first carried out, namely the F-test. This test is a test of sample similarity, namely whether the variance of samples taken from the same population is uniform or not..

**Results And Discussion**

## Description of Learning Tools Development Results

Based on the first research objectives, a STAD cooperative learning tool was prepared on the topic of sequences and series. The resulting learning toolss consist of Learning Implementation Plan (RPP), Student Worksheet (LKS), and Learning Outcomes Test (THB). To find out the quality of learning toolss, learning toolss were tested. The achievement of the criteria for a good learning tools is determined based on the results of expert validation, analysis of student activity data, analysis of the teacher's ability to manage learning, analysis of student responses, and Learning Outcomes Test (THB). The results of testing the learning tools can be seen in the following table:

Table 3 Achievement of good quality learning tools criteria

|  |  |  |
| --- | --- | --- |
|  | **Aspect** | **Information** |
| 1. | Valid* Expert Validation
* THB
 | * Valid
* Valid, reliable, and sensitive
 |
| 2. | Practical* Teacher’s ability to manage learning
* Student’s Activity
 | * Good
* Effective
 |
| 3. | Effective* Student’s response
* Mastery Learning
 | * Positive
* Complete
 |

Thus, based on the data that the criteria for good learning tools above, obtained a good STAD type of cooperative learning tools on the topic of rows and rows in class XII SMK NU 1 Karanggeneng Lamongan.

## Description of Implementation Results

The learning tools used are the final tools developed in the previous stage. The data collected at this stage were the teacher's ability to manage learning, student activity data, student response data, and student learning outcomes data from the experimental class. The data were analyzed descriptively to determine the effectiveness of STAD cooperative learning.

1. Teacher Ability in Managing Learning

The score of each aspect of the teacher's ability that is assessed at each meeting is at least 3 or in the category of at least good enough. Thus, it can be concluded that the teacher's ability to manage learning in terms of quality of learning (quality of instruction), the suitability of learning levels (Appropriate Levels of Instruction), incentives, and time have met the criteria for learning effectiveness.

1. Student activities

In terms of student activities during the learning process for each meeting, it can be explained that student activities are in accordance with student activities that are expected to appear in cooperative learning type STAD.

1. Student Response

From the results of the student response data, it is known that the positive responses of students to all aspects are above 80%. In accordance with the established criteria, the student's response is said to be positive.

1. Completeness of Learning Outcomes

Data about the completeness of student learning outcomes can be seen in table 4 below.

Table 4 Students Learning Outcomes (Experimental Class)

|  |  |  |
| --- | --- | --- |
|  | Description | Amount |
| 1 | Students who complete their studies | 26 |
| 2 | Students who do not complete their studies | 5 |
| 3 | Percentage of students who completed learning | 83,87 % |
| 4 | Classical Completeness | Complete |

Based on the description above, it can be seen that the STAD type of cooperative learning is effective for teaching sequence and series material in class XII.

## Inferential Statistical Analysis: Sample Homogeneity Test

To test the homogeneity of the sample, the variance similarity test was used, namely the F-test to test the following statistical hypothesis.

H0 : σ12 = σ22 (Same population variance)

H1 : σ12 ≠ σ22 (The population variance is not the same)

From the data analysis on the difference between the pretest and posttest in the experimental class and the control class, the following data were obtained.

Tabel 5. Data on Difference of Pretest and Post Test Control Class and Experiment Class

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Description** | **Experimental Class** | **Class Control** |
| 1. | Number of data | 31 | 33 |
| 2. | Mean | 46,61 | 38,09 |
| 3. | Variance | 76,97 | 69,96 |

Based on the data in Table 5. and with a significance level of α = 0.05, it is obtained that Fcount = 1.100, namely by dividing the variance value of the experimental class by the variance value of the control class, while Ftable = Fα (31-1, 33-1) = F0,05 (30, 32) = 1,81. Thus Fcount < Ftable, so that H0 is accepted and H1 is rejected, which means that the variance of the two populations is the same.

## Inferential Statistical Analysis: Mean Similarity Test

Based on the data in Table 5, a combined variance 73,35 with degrees of freedom 33 + 31 - 2 = 62 is obtained and is used in the t-test to test the following statistical hypothesis.

H0 : µ1 = µ2 (the average difference between the two pretest and post test scores class is the same)

H1 : µ1 > µ2 (the average difference between the pretest and post test scores experiment is better than the control class)

With a significance level of α = 0.05, the obtained value tcount = 3,977 and ttable = t0,05;62 = 1,671. By using the right side statistical test and because tcount > ttable, then H0 is rejected and H1 is accepted, which means that the average difference between the pretest and post test scores of the experimental class is significantly better than the difference between the pretest and post test scores of the control class.

Based on the two mean test (t-test) that has been implemented, it can be concluded that the average difference between the pretest and posttest scores of the experimental class is significantly better than the difference between the pretest and posttest scores of the control class. This means that the learning outcomes of experimental class students who are taught by cooperative learning type STAD are significantly better than the learning outcomes of control class students who are taught using conventional learning. Therefore the conclusion of the answer to the third sub-question of the research question is that student learning outcomes taught using STAD type cooperative learning are better than student learning outcomes taught using conventional learning for line and series material in class XII SMK.

**CONCLUSION**

 Based on the results of the development of learning tools using the Plomp development model that has been carried out, it can be concluded:

1. The learning toolss produced in the process of developing the STAD Type Cooperative learning tools have the following results:
2. Valid because the results of expert validation show that the validator's assessment of learning tools which include lesson plans, worksheets, and THB is included in the valid (good) category.
3. It is practical because the validator states that the learning tools can be used in the field with small revisions, in testing the learning tools the teacher's ability to manage learning for each aspect is at least good, and student activities during the learning process are included in the effective category,
4. Effective because students' responses to learning toolss are included in the positive category, the results of learning tests (pretest and posttest) show that the test kits meet the criteria of validity, reliability, and sensitivity, and learning completeness classically reaches 78.95%.

From the above results, it can be concluded that the STAD type of cooperative learning tools in the class XII class of SMK material is of good quality.

1. The effectiveness of learning.
2. The ability of the teacher to manage learning in all aspects in the minimum criteria is good
3. Effective student activities,
4. Student responses to positive learning
5. Completeness of classical learning completely,

From the above results, it can be concluded that the STAD cooperative learning type is effective for teaching the material for the XII class of SMK.

1. Comparison of Student Learning Outcomes

The learning outcomes of class XII students on the topic of sequences and series taught by cooperative learning type STAD were better than the learning outcomes of class XII students on the topics of sequences and rows taught by conventional learning.

Based on points 1, 2, and 3, it can be concluded that this study has produced STAD cooperative learning tools that can improve student learning outcomes in the class XII class of SMK. The learning tools referred to include the Learning Implementation Plan (RPP), Student Worksheets (LKS), and Learning Outcomes Test (THB).

Furthermore, based on the description of the research results, it can be suggested that:

1. The learning tools developed in this study (RPP, LKS, and THB) are proven to be of good quality. Therefore, this learning tool can be used as an alternative learning tool for mathematics teachers to teach Statistics material, especially the topic of presenting statistical data.
2. Teachers can apply STAD-type cooperative learning as alternative learning because it is proven to be effective in teaching sequence and series topics in class XII SMK.
3. Other researchers can carry out similar research for other mathematical material because this research is only limited to the topics of sequences and series.
4. Other researchers who want to develop learning tools can choose the Plomp learning tools development model because it is proven to produce good quality learning tools
5. For learning tools development researchers, if interested in conducting similar research, it is necessary to minimize the weaknesses in this study.

References

Soedjadi. Kiat Pendidikan Matematika di Indonesia. Surabaya: Dirjen Dikti Depdiknas. 1999.

Isjoni. Pembelajaran Kooperatif Meningkatkan Kecerdasan Komunikasi Antar Peserta Didik. Yogyakarta: Pustaka Pelajar. 2013.

Mulyasa, H.E. Menjadi Guru Profesional. Menciptakan Pembelajaran Kreatif dan Menyenangkan. Bandung: PT Remaja Rosdakarya. 2010.

Rusman. Model-Model Pembelajaran. Mengembangkan Profesionalisme Guru. Second Ed. Jakarta: PT Raja Grafindo Persada. 2012.

Hudojo, Herman. Mengajar Belajar Matematika. Jakarta: Departemen Pendidikan dan Kebudayaan. 1998.

Sanjaya, Wina. Strategi Pembelajaran Berorientasi Standar Proses Pendidikan. Jakarta: Kencana Prenadamedia Grup. 2014.

Mahmud, Amir. Atmojo, Tri K. Usodo, Budi. Eksperimentasi Model Pembelajaran Kooperatif Tipe STAD dan Jigsaw Pada Pokok Bahasan Bentuk Aljabar Ditinjau dari Perhatian Orang Tua Siswa Kelas VII SMP Negeri di Kabupaten Cilacap Tahun Pelajaran 2010/2011. 2012.

Zakaria, Effandi. Chin, Chung Lu. Daud, Yussoff Md. The Effects of Cooperative Learning on Students’ Mathematics Achievement and Attitude towards Mathematics. Journal of Social Sciences. 2010.

Eminingsih. Peningkatan Hasil Belajar Matematika Melalui Pembelajaran
Kooperatif Tipe STAD Pada Siswa Kelas VII E SMP Negeri 3 Batang. 2013.

Slavin, Robert E. Cooperatif Learning: Theory, Research, and Practice, Second Edition. USA: Allyn and Bacon. 1995.

Plomp, Tj. Educational Design: Introduction. From Tjeerd Plomp (eds). Educational & Training System Design: Introduction. Design of Education and Training (in Dutch). Utrecht (the Netherlands): Lemma. Netherland.Faculty of Educational Science and Technology, University of Twente. 1997.

Nieveen, N. Prototyping to Research Product Quality from Design Approaches And Tools In Education And Training. Nederlands : Kluwer Academy Publisher. 1999.