The Development of STAD Cooperative Learning Tools to Improve Student Learning Outcomes on Sequences and Series Topic

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Abstract

This study aims to develop a STAD cooperative learning tools that is able to improve students' learning outcomes of 12th grade on the topic of series and sequences. This research is quasi-experimental research with preliminary development research conducted in two stages, namely learning tools development phase and experiment phase. The development phase follows plomp model that consists of five phases of development, namely: 1) preliminary investigation, 2) design, 3) realization, 4) test, evaluation, and revision, and 5) implementation. learning tools are developed in the form of: (1) lesson plan, (2) student worksheet, and (3) achievement test. While the experiments aim to determine the effectiveness of STAD cooperative learning by using developed learning tools and to compare students' learning outcomes that taught by STAD cooperative learning with students' learning outcome that taught by conventional learning. The results of this study showed that: (1) STAD cooperative learning tools have met the criteria for valid, practical, and effective learning tools, (2) STAD cooperative learning is effective to teach the topic of series and sequences, (3) the students' learning outcomes that taught by STAD cooperative learning is significantly better than students' learning outcomes that taught by conventional learning. STAD cooperative learning tools can be used as an alternative learning media on sequences and series topic.

Keywords: Mathematics Learning; Sequences and Series; STAD Cooperative Learning

Abstrak

Penelitian ini bertujuan untuk menghasilkan perangkat pembelajaran kooperatif tipe STAD yang dapat meningkatkan hasil belajar siswa kelas 12 pada materi barisan dan deret. Penelitian ini merupakan penelitian eksperimen semu yang didahului penelitian pengembangan yang dilaksanakan dalam dua tahap, yaitu tahap

pengembangan perangkat dan tahap eksperimen. Tahap pengembangan perangkat menggunakan *model plomp* yang terdiri dari lima tahap pengembangan, yaitu: 1) investigasi awal, 2) desain, 3) realisasi, 4) tes, evaluasi dan revisi, 5) implementasi. Perangkat pembelajaran yang dikembangkan berupa: (1) Rencana Pelaksanaan Pembelajaran (RPP), (2) Lembar Kerja Siswa (LKS), dan (3) Tes Hasil Belajar (THB). Sementara itu, tahap eksperimen bertujuan untuk mengetahui keefektifan pembelajaran kooperatif tipe STAD dengan menggunakan perangkat pembelajaran yang dikembangkan sekaligus untuk membandingkan hasil belajar siswa kelas XII pada topik barisan dan deret yang diajar dengan pembelajaran kooperatif tipe STAD dengan hasil belajar siswa yang diajar dengan pembelajaran konvensional. Hasil penelitian ini menunjukkan bahwa: (1) perangkat pembelajaran kooperatif tipe STAD telah memenuhi kriteria perangkat pembelajaran yang valid, praktis, dan efektif, (2) pembelajaran kooperatif tipe STAD efektif untuk mengajarkan materi deret dan barisan, (3) Hasil belajar siswa yang diajar dengan pembelajaran kooperatif tipe STAD secara signifikan lebih baik dibandingkan dengan hasil belajar siswa yang diajar dengan pembelajaran konvensional. Perangkat pembelajaran kooperatif STAD dapat digunakan sebagai media pembelajaran alternatif pada topik barisan dan deret.

Kata Kunci: Barisan dan Deret; Pembelajaran Kooperatif Tipe STAD; Pembelajaran Matematika

Introduction

Mathematics is an essential lesson in all sciences (Wahyuni, 2020). Soedjadi, (2000) says that mathematics, as one of the basic sciences, both its applied aspects and its reasoning aspects, has a vital role in efforts to master science and technology. As a fundamental science, mathematics can be used in various disciplines and plays a critical role in everyday life (Maula et al, 2018; Auliya, 2019; Malasari, Herman, & Jupri, 2019; Bhoke, 2020; Richardo, 2020; Taskiyah & Widyastuti, 2021). Thus, master of mathematics is essential for students to face increasingly complex life problems in the future (Lutvaidah, 2015). To achieve practical learning goals, collaboration and educative interactions between students and educators are needed (Ngaeni & Saefudin, 2017; Alfian & Arifanti, 2020). However, in reality, there are still many mathematics lessons that use conventional methods (Maulidah, 2018; Sukiyanto, 2019). Even by using this learning method, teachers are required to develop and apply various learning methods to students (Sundari & Indrayani, 2019; Annisah, 2014).

According to Isjoni, (2013), learning is an educator's effort to help students carry out learning activities. The purpose of learning is to realize the efficiency and effectiveness of learning activities carried out by students. In line with this, Mulyasa (2010), states that teachers must provide learning facilities for all students to develop their potential optimally (Sulianto, 2008; Sihaloho et al, 2020). Thus, teachers must be able to position themselves as facilitators who are always ready to

provide convenience and serve students according to their interests, abilities and talents.

Currently, one of the methods often applied by teachers is to use the cooperative learning method (Permana, 2016). According to Isjoni, (2013), collaborative learning is learning that uses small groups so that students work together to achieve learning objectives. Students in cooperative groups discuss, help each other, and invite each other to solve learning problems. With collaborative learning, the teacher can condition students to be active and provide mutual support in group work to solve problem material in education.

Cooperative learning is based on constructivism theory. Rusman (2012) states that the constructivism theory approach in education is an approach where students must individually find and transform complex information, examine the report with existing rules and revise it if necessary. Cooperative learning encourages students to interact actively and positively in groups. This allows the exchange of ideas and the examination of one's thoughts in an atmosphere that is not threatened by the philosophy of constructivism (Yusuf & Arfiansyah, 2021). Thus, education should be able to condition and provide encouragement to optimize and generate student potential to ensure the occurrence of dynamics in the learning process.

In conventional learning, the teacher acts as the primary source of information for students. Traditional knowledge of mathematics has become a teacher's habit, namely by using the lecture method and practice questions (Hudojo, 1998; Dewi, 2018). So that learning is only centered on the teacher. Hartono et al. (2012) stated that conventional wisdom has many weaknesses; namely, it can accommodate various characteristics and abilities of students. Students are grouped into heterogeneous groups mainly based on their academic skills. Afifah et al, (2019) suggested several reasons for choosing heterogeneous grouping. First, heterogeneous groups provide opportunities for mutual teaching and support. 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 answers, and correct things that are not quite right.

One of the learning models that is simple and easy to apply is the STAD (Student Team Achievement Division) type of cooperative learning model (Arend, 1989). Several studies related to the STAD type of cooperative learning model have been carried out. 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 to btain 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 toward mathematics.

The three studies above are evidence that the STAD type of cooperative learning method can positively impact learning mathematics in the classroom and can further activate students in learning (Dewi et al, 2019). Students are directly involved in constructing their knowledge so that better understanding and learning outcomes of mathematics are expected. The essence of STAD is that the teacher conveys the competencies and indicators that must be achieved then the students join in groups to divide and complete the tasks given by the teacher (Nugroho et al., 2009).

One of the mathematics topics taught in class XII at the SMK level is sequences and series. Arrangements and strings are the mathematical topics in which many concepts can be applied in everyday life (Setyadi & Qohar, 2017; Masjuni, 2016). These concepts should be well understood by students and not just memorized. For these concepts to be well understood, students must be actively involved in learning. Students are expected to actively construct their understanding through group discussions and exchange opinions with the teacher and with their group friends. One method that students in learning can use is the STAD type cooperative learning method.

To be able to apply mathematics learning through cooperative learning type STAD, learning tools are needed following this method. Learning equipment is a very important factor to support the smooth teaching and learning process. For the learning process to run well and achieve learning objectives, good learning tools are neded 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. After the development stage, then the experimental stage was carried out aiming to determine the effectiveness of STAD type cooperative learning by using learning

tools that were developed at the same time to compare the learning outcomes of class XII students on sequences and series topic taught with STAD type cooperative learning with student learning outcomes taught by learning conventional.

Method

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 tool that has been developed and that meets the criteria for a good learning tool, 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. This model uses two times data collection (pretest and posttest). This trial design can be described as follows:

Table 1. Learning Tools Trial Design

Class	Pretest	Treatment	Post Test
Trial	T_1	X	T_2

Information:

T_1 : Pretest is used to determine the students' ability before joining the lesson

T_2 : Posttest is used to determine students' ability after participating in the lesson

X : Treatment, namely the implementation of learning cooperative type STAD

T_1 : T_2 (Pretest questions are the same as post test questions)

The research instrument developed was a validation sheet for learning tools, 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 achievement test are at least good (valid), (2) the knowledge assessment sheet (Achievement 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 minimum criteria of mastery learning 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 2.

Table 2. Learning Tools Experiment Design

Group	Pretest	Treatment	Post test
Experiment	T_1	X	T_2
Control	T_1	Y	T_2

Information:

T_1 : Pretest value of the experimental group and group control

T_2 : Posttest value of the experimental group and group control

X   : Application of type STAD cooperative learning

Y   : Application of conventional learning

T_1 : T_2 (Questions used for pretest and posttest 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 tools

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:

a. Classical learning outcomes are complete.

b. The teacher's ability to manage learning is at least good.

c. Effective student activity

d. Positive student response

To see the difference in student learning outcomes taught by STAD cooperative learning and conventional learning, the data on the difference between the pretest and posttest results of each student from the control class and the experimental class at the experimental stage will be analyzed using two-mean inferential statistics, namely the t-test. This inferential statistical analysis was used to test the hypothesis that student learning outcomes taught using STAD

cooperative learning were better than student learning outcomes taught using conventional learning on the topic of sequences and series. Before the t-test was carried out, the sample homogeneity test was first carried out, namely the F-test. This test is a test of sample similarity, namely whether or not the variance of the samples taken from the same population is uniform.

Results

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 tools consist of Lesson Plan, Student Worksheet, and Achievement Test. To find out the quality of learning tools, learning tools were tested. The achievement of the criteria for a good learning tool 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 achievement test. The results of testing the learning tools can be seen in the following Table 3:

Table 3 Achievement of Good Quality Learning Tools Criteria

No.	Aspect	Information
1.	Valid	
	Expert Validation	Valid
	Achievement test	Valid, reliable, and sensitive
2.	Practical	
	Teacher's ability to manage learning	Good
	Student's Activity	Effective
3.	Effective	
	Student's response	Positive
	Completeness of classical learning outcomes	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.

a. 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.

b. 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.

c. 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.

d. 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)

No.	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

To see the difference in student learning outcomes taught by STAD cooperative learning and conventional learning, the data on the difference between the pretest and posttest results of each student from the control class and the experimental class at the experimental stage will be analyzed using two-mean

inferential statistics. To be able to perform this two-mean test, there are two conditions that must be met, namely: (1) the data analyzed is in the form of a normal distribution or assumed to be normally distributed, and (2) the selected samples must be homogeneous. For the first requirement, because the number of students from the experimental class and control class is more than 30, the assumption that the data is normally distributed is fulfilled. This is in accordance with the opinion of Walpole [1995] which states that if the number of samples is more than or equal to 30 (n ≥ 30), then regardless of the shape of the population, the distribution of the sample data will approach the normal distribution. Meanwhile, to fulfill the second requirement, a homogeneity test of the sample will be carried out.

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.

$H_0 : \sigma_1^2 = \sigma_2^2$ (Same population variance)
$H_1 : \sigma_1^2 \neq \sigma_2^2$ (The population variance is not the same)

The population in this study were grade 12 students of SMK NU 1 Karanggeneng Lamongan in the 2015/2016 academic year. 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. Difference of Pretest and Post Test Control Class and Experiment Class

No.	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 F_{count} = 1.100, namely by dividing the variance value of the experimental class by the variance value of the control class, while F_{table} = $F_{\alpha\,(31-1,\,33-1)}$ = $F_{0,05\,(30,\,32)}$ = 1,81. Thus $F_{count} < F_{table}$, so that H_0 is accepted and H_1 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 $S_p^2 = 73,35$ with degrees of freedom 33 + 31 - 2 = 62 is obtained and is used in the t-test to test the following statistical hypothesis.

H_0: $\mu_1 = \mu_2$ (the average difference between the two pretest and post test scores class is the same)

H_1: $\mu_1 > \mu_2$ (the average difference between the pretest and post test scores experiment is better than the control class)

With a significance level of $\alpha = 0.05$, the obtained value $t_{count} = 3{,}977$ and $t_{table} = t_{0,05;62} = 1{,}671$. By using the right-side statistical test and because $t_{count} > t_{table}$, then H_0 is rejected and H_1 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

Discussion

Discussion of Learning Tools Development

Based on the data on the achievement of the criteria in Table 3, the STAD cooperative learning tools is obtained with good quality. In Table 3 it can be seen that the teacher is able to manage learning well, student activities during learning are categorized as effective and student responses are categorized as positive. This is in accordance with the opinion of Hudojo, (1988) that the teacher's ability to convey material and mastery of the material greatly affects the learning process. And in line with research by Eminingsih, (2013) which concluded that STAD cooperative learning can significantly increase student activity and response. Meanwhile, based on the results of the THB, it can be seen that Classical Completeness has been fulfilled. The THB results strengthen the opinion of Isjoni, (2013), namely that cooperative learning can improve student achievement or other academic tasks and can improve student learning outcomes.

Application of Learning Tools in the Experimental Class

Based on the results of inferential statistical analysis, the hypothesis which reads that the average difference between the pretest and posttest scores for the experimental class is better than the average difference between the pretest and posttest scores for the control class is accepted, meaning that it is true that the average difference between the pretest and posttest scores for the experimental class is better. significantly than the average difference between the pretest and posttest scores for the control class. This shows that the learning outcomes of experimental class students on the topic of sequences and series taught by cooperative learning type STAD are better than the learning outcomes of control class students on the topic of sequences and series taught by conventional learning. In accordance with the results of testing the hypothesis, in this study it can be concluded that the learning outcomes of class XII students on the topic of sequences and series taught by cooperative learning type STAD are better than the learning outcomes of class XII students on the topic of sequences and series taught by conventional learning.

Thus, the results of this study further strengthen the results of research conducted by Amir Mahmud, Tri Atmojo and Budi Usodo, (2012) who concluded that the STAD type cooperative learning method can improve student achievement better than conventional methods. In another study, Effandi Zakaria, Lu Chung Chin and Md. Yusoff Daud, (2010) using a control class and an experimental class also concluded that STAD type cooperative learning can improve student achievement and positive attitudes towards mathematics. The conclusion of this study also recommends that mathematics teachers use the cooperative learning model regularly and effectively in order to obtain maximum learning outcomes.

Conclusion

Based on the process of developing STAD cooperative learning tools that have been carried out, it can be said that the resulting tools are of good quality because they meet the criteria, are practical and effective. Meanwhile, the effectiveness of learning using learning tools that have been produced is categorized as effective because it has met the predetermined criteria, namely the teacher is able to manage learning well, student activities are effective, student responses are positive, and classical learning completeness is met. In the next stage, the experimental class showed that the learning outcomes of class XII students in series and sequences taught with STAD cooperative learning were better than the learning outcomes of 12th grade on the topic of series and sequences taught by conventional learning. Based on this, it can be said that this research has produced a STAD

cooperative learning tools that can improve student learning outcomes in the material for 12th grade. This research can be used as a consideration to apply STAD cooperative learning as an alternative learning method with the aim of activating students more in learning because STAD cooperative learning has proven to be effective in learning mathematics. Furthermore, based on the description of the research results, it can be suggested that other researchers can carry out similar research for other mathematical material because this research is only limited to the topics of sequences and series.

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