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The Effect of the Implementation of Learning Models *Student Teams Achievement Division* (Stad) Stem Based on *Mathematical Critical Thinking Ability* Reviewed from Mathematics Learning Styles

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ABSTRACT

In initial observations, it was seen that students did not write down what they knew (interpretation), were not precise in making mathematical models (analysis), were less precise in using strategies to solve problems (evaluation), and had no conclusions (inference). After paying attention, students have different learning styles. However, the learning model used has not been able to improve mathematical critical thinking skills in terms of learning style. This research aims to find out how mathematical critical thinking skills are treated with the STEM-based STAD learning model in terms of learning styles. This type of research is quantitative research with research subjects namely class X students at MAN 1 Muaro Jambi. The research design used was a posttest only control design. The population was 115 students from 4 classes and the sample consisted of 3 classes, namely experimental class I (29 students), experimental class II (29 students), and control (28 students). The sampling technique was carried out using the cluster random sampling technique. The instruments in this research were observation sheets, learning style questionnaires, and mathematical critical thinking ability tests. The data obtained in this study were analyzed using a two-way ANOVA test. The results of the research show that: 1) There is an influence of the application of the STEM-based STAD model on mathematical critical thinking skills where the significance value of the learning model is $0{,}003 < 0{,}05$*, so* H_0 *is rejected or* H_1 *is accepted, 2) There is no influence of learning style on mathematical critical thinking skills with The significance value for learning style is* $0{,}725 > 0{,}05$*, so* H_1 *is rejected or* H_0 *is accepted, and 3) There is no interaction between the application of the STEM-based STAD model and learning style on mathematical critical thinking skills with a significance value of* $0{,}508 > 0{,}05$*, so* H_1 *is rejected or* H_0 *accepted. The results of the research concluded that the STEM-based STAD learning model applied in experimental class I was more effective for mathematical critical thinking skills, as evidenced by the average mathematical critical thinking ability of the STEM-based STAD learning model of* 58,7608 *which is greater than the average. using STAD and direct instruction.*

INTRODUCTION

Mathematics is one of the subjects included in the structure curriculum and is taught at every level of education. Mathematics can practice somebody for think rational and use logic. Matter This shows that studying mathematics is something that important in life and also on activity learn how to teach. In activity learn how to teach especially on eye lesson mathematics needed mathematical critical thinking skills Which strong. According to Sukriadi et al. (2015) mathematical critical thinking skills is a process of students' ability to identify suspected problems, determine the core of a problem, determine the impact of a solution to a problem taken, detect bias based on different points of view, put forward concepts, theorems or definitions used in problem solving, and evaluate relevant opinions in solving problems.

According to research from Raj et al. (2022) explains how important and beneficial critical thinking skills are. Everyone, without a question, analyzes, and it is our nature to do so. Thinking, on the other hand, is often casual and informal. Much of our thinking is misleading, distorted, incomplete, or biased if left to chance. The quality of our lives, and the quality of what we produce, create, or build, is directly proportional to the quality of our brains. Facts This emphasizes the importance of critical thinking skills. The benefits of critical thinking skills,

namely giving students the opportunity to recognize and manage their own learning, students who use critical thinking skills approach the subject matter more attentively and effectively, ask more difficult questions, and are more actively involved in the learning process. However, each student in mathematical critical thinking skills has a different learning style.

Learning style is a unique way of learning for each individual. So that ability somebody for understand and absorb lesson differentits level. So from That, every person must to go through method Which different ForCan understand a information or lesson Which same (Dewi et al., 2023) . The relationship between learning styles and critical thinking skills: tailored instruction and critical thinking development, diverse approaches and critical thinking, cognitive load and information processing, empirical studies and evidence, and teaching strategies. In customized instruction and critical thinking development on the alignment of teaching models are explained according to Coffield et al. (2004) when the learning model is aligned with the students' learning styles, this can increase engagement and understanding, providing more fertile ground for the development of critical thinking skills. For example, Visual learners benefit from diagrams and charts, while auditory learners benefit more from discussions and lectures. Aligning teaching models with these preferences can facilitate deeper understanding and critical analysis of the material. Then teaching strategies for differentiated instruction Tomlinson (2001) explains that educators can support the development of critical thinking by differentiating instruction to meet different learning styles, ensuring that all students have the opportunity to engage deeply with content. This may involve offering a variety of formats for learning materials and activities, allowing students to choose the mode of instruction. that suits them best.

M. Tanjung (2019) explains that critical mathematical thinking skills in terms of students' mathematics learning styles are expected to be able to analyze and clarify questions, identify and evaluate existing assumptions, compile clarifications with valuable considerations, compile explanations, make conclusions and arguments for achieve the desired competencies in student learning completion . However, the learning process in Indonesia is still very focused on one direction. This was seen when the author conducted initial observations at Madrasah Aliyah Negeri 1 Estuary Jambi on January 2024. The teaching model that is not in accordance with the students' learning style (for example, visual, auditory, kinesthetic) can result in hampered understanding and critical thinking skills of students in mathematics. This was observed through classroom observations conducted in class X as seen in the following picture:

Figure 1. In-Class Observation

Besides that, the use of conventional teaching models that focus too much on lectures and repetitive exercises without providing opportunities for exploration and self-discovery can hinder the development of critical thinking. The learning model implemented also requires other innovations in the use of learning models to improve critical mathematical thinking skills in terms of students' mathematical learning styles. As a result, critical mathematical thinking skills student become relatively low in eye lesson mathematics. This was obtained through unwritten interviews on observations that showed students in arguing, question and answer and can be observed on the answer sheet worked on by one of the following students:

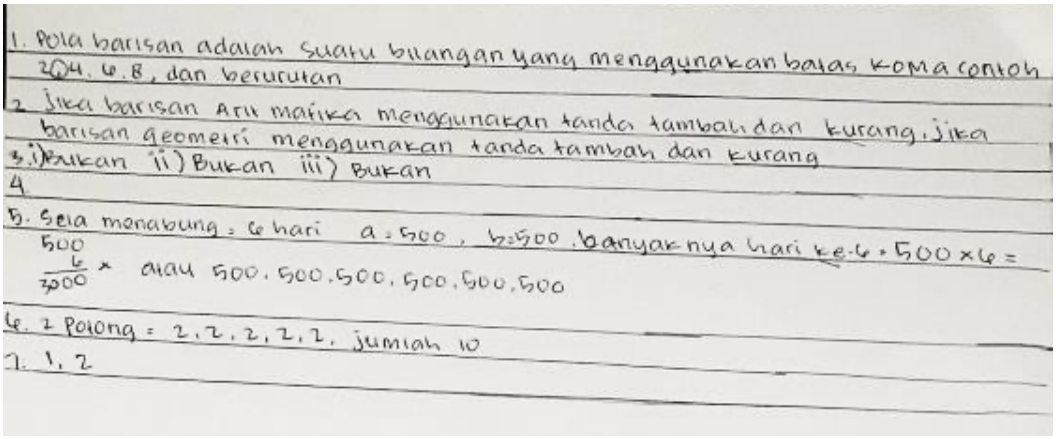

Figure 1 Student Answer Sheet

In the initial observation through the observation shown in table 1.1 and seen in the percentage of relatively low test scores. Then randomly selected students to work on the questions given to see critical thinking skills and conducted unstructured interviews obtained student answers according to figure 1.2 which shows the lack of this ability. On the answer sheet, it can be seen that students do not write known which shows that students understand the problem in question number 6 (interpretation), students are less precise in making mathematical models in questions 5 and 6 (analysis), students are less precise in using strategies to solve problems (evaluation), and there is no conclusion in questions 5 and 6 (inference). After being observed again, students in the class also have different learning styles. However, the learning model used has not been able to improve critical mathematical thinking skills in terms of students' mathematical learning styles. For That need existence implementation model learning new Which Good as well as can optimize critical thinking skills in mathematics student on eye math.

Model learning that currently getting a lot response but it has not been implemented optimally in the world of education is a cooperative learning model. According to Supriyono (2019) that the cooperative learning model was developed to achieve learning outcomes. in the form of academic achievement, tolerance, accepting diversity, and developmentsocial skills. With this learning model, students have the opportunity for communicate And interact social with student Which other.Even though there is diversity among students, there will still be competition. Which positive especially in increase critical mathematical thinking skills viewed from students' mathematics learning styles optimally. Meanwhile, the teacher in this lesson acts as motivator and activity facilitator student.

This requires active student involvement in understanding. material in the learning process. Understanding the contents of the lesson will be more effective if there is active interaction, between students and students, students and teachers, and students with learning resources. In addition, to achieve critical mathematical thinking skills, it is reviewed from the students' mathematics learning styles. Which optimal need application or enter experience from everyday life in learning process.

Innovative learning models in facing demands world education Which covers a small groups of students working as a team to complete a task a problem, to complete a task or to do something For reach objective together other. Example model learning cooperative is STAD. According to Slavin (2012) , stated that this learning model is the simplest and most appropriate learning model for teachers who are just starting to use the cooperative learning approach. According to Slavin (2012) stated that there are three important concepts in the STAD type cooperative learning model, namely: group rewards, which will be given if the group achieves the specified criteria, individual responsibility, meaning that the success of the team depends on the individual learning of all team members, and opportunities for success. equal, meaning that all students contribute to their team by improving their performance from the previous one. This will ensure that high, medium and low achieving students are all equally challenged to do their best, and that the contributions of all team members There is a value. The essence of STAD is that the teacher delivers a material, then the students join their groups of four or five people who are a mixture according to their level of achievement, gender and tribe to solve the questions given by the teacher and make surethat all team members have mastered the lesson. After completion student deliver his job in a way single for every group to Teacher. Team Which get score highest get award, then all students are given quiz or test about the material.

STAD type cooperative learning is not the same as just studying. in groups. The basic elements of STAD type cooperative learning are differentiate it with distribution group Which done haphazard.Implementation procedure model learning cooperative type STAD with will really enable teachers to manage the class more effectively. In addition, it also student will become more active in Study Because will always interact with friends Which other in do task on learningmathematics.

Slavin (2012) explains that in learning STAD, student placed in group learning consisting of four or five students who are a mixture of students with different academic abilities so that in every group there is student

Which achieve low, currently And high or variation type sex, group race And ethnicity or group social others. The teacher first presents the material in class, then the class members The team studied and practiced the material in groups. Each groups are given printed books or something else which contains materialWhich will discussed. Each group discuss book the with their group, ask each other, discuss the problem later, Students are given exercises or evaluations. These tasks must be mastered by every member group. Each member group must give scores to the group to get a perfect score and will get an award. The advantages of the STAD learning model according to Shoimin (2019) , namely: 1) Students work together to achieve goals by upholding group norms; 2) Actively acting as peer tutors to improve group success; 3) Interaction between students as their ability to express opinions increases. Meanwhile, the disadvantages of the STAD learning model are: 1) The contribution of low-achieving students becomes less; 2) High-achieving students will lead to disappointment because the role of smart members is more dominant; 3) It takes longer for students so that it is difficult to achieve curriculum targets. The STAD (Student Teams Achievement Divisions) learning model is suitable as a foundation for STEM (Science, Technology, Engineering, and Mathematics) because it combines several principles and practices that are in accordance with STEM education. Here are the reasons: 1) Collaboration and Teamwork: The STAD model encourages collaboration among students in the form of teams. In STEM, collaboration is an important aspect because STEM projects often involve teamwork to solve complex problems and to develop innovative solutions. 2) Project-Based Learning: STAD facilitates project-based learning where students work together to complete tasks relevant to STEM content. This learning allows students to apply the concepts they are learning in real-world situations and deepen their understanding. 3) Problem Solving: The STAD model encourages students to develop problem-solving skills by providing challenges and problems that students must solve collaboratively. These skills are important in STEM because the STEM process often involves identifying, analyzing, and solving problems. 4) Critical Thinking Skills: STAD provides opportunities for students to discuss and solve problems together. These discussions encourage critical thinking because students must formulate arguments, present evidence, and conclude the most rational solution. 5) Active Student Involvement: The STAD model places students as active subjects in their learning process. They not only receive knowledge from the teacher, but also play an active role in constructing their own understanding. This is consistent with the STEM approach that emphasizes active learning and exploration. 6) Development of 21st Century Skills: STAD helps students develop 21st century skills such as communication, collaboration, problem solving, and critical thinking. These skills are essential in STEM because they prepare students for success in an increasingly changing and complex workforce. Thus, the STAD learning model provides an effective framework to support STEM education by promoting collaboration, project-based learning, problem solving, critical thinking, active student engagement, and the development of 21st century skills. In the STEM-based STAD learning model, this model can be strengthened even better.

According to Council et al. (2012) the application of STEM in learning must emphasize several aspects, namely: (1) asking questions and explaining problems; (2) developing and using models; (3) designing and implementing research, (4) interpreting and analyzing data; (5) using mathematical and computational thinking, (6) making explanations and designing solutions; (7) participating in argumentation activities based on existing evidence (8) obtaining information, providing evaluations and conveying information.

The main reason for the researcher in conducting this study was to see the students' critical mathematical thinking ability as reviewed from the mathematics learning style, and whether it can be influenced through the application of the STEM-based STAD learning model. In addition, the use of the STEM-based STAD learning model can improve students' critical mathematical thinking ability and can align students' learning styles according to Chang et al. (2024) explains that when the learning model is in line with the student's learning style, it can increase student engagement and understanding for the development of critical thinking skills and according to Felder & Brent (2024) that by integrating various learning models, such as combining teaching aids with group discussions and practical activities, students can develop a more holistic understanding and improve their critical thinking skills. For this reason, research is needed on this matter which will be conducted in class X on trigonometry material. Based on exposure on researcher do study Which entitled **"The Influence of the Implementation of Learning Models "STEM-Based *Student Teams Achievement Division* (STAD) on *Mathematical Critical Thinking Ability* Reviewed from Mathematics Learning Styles".**

Despite the significant advancements in educational methodologies and learning models, there remains a lack of in-depth research focusing on the integration of STEM-based STAD (Student Teams Achievement Division) in enhancing mathematical critical thinking skills, specifically within the context of students' learning styles. Existing studies often emphasize either STEM-based models or cooperative learning independently, leaving a gap in understanding the combined effects of these approaches in improving critical thinking in mathematics. Furthermore, most research is conducted in urban educational institutions, overlooking the unique challenges and learning dynamics in suburban or rural schools, like the research setting in this study.

The novelty of this research lies in its attempt to integrate STEM-based STAD learning models with a focus on students' mathematical learning styles, providing a more personalized and effective learning experience. By combining cooperative learning principles with STEM education, this study introduces an innovative approach that not only enhances critical thinking skills but also addresses the diverse learning preferences of students. This dual focus on methodology and individual learning style alignment is a distinctive aspect that has not been

extensively explored in prior studies.

The primary objective of this study is to examine the influence of the STEM-based STAD learning model on mathematical critical thinking skills when reviewed from different mathematics learning styles. Specifically, this research aims to determine the effectiveness of the model, assess its applicability across varied learning styles, and evaluate its potential for broader implementation. The benefits of this study are twofold: theoretically, it contributes to the growing body of literature on innovative learning models and critical thinking skill development. Practically, it offers educators a proven framework to enhance teaching methods, foster active learning, and better cater to the diverse needs of students, thereby improving overall academic outcomes in mathematics.

METHOD

This research was conducted at State Islamic Senior High School 1 Muaro Jambi (State Islamic Senior High School Sungai Gelam). This school is located on Jalan Sungai Gelam-Petaling KM 08, Sungai Gelam Village, Sungai Gelam District, with research on class X students. The research time was the odd semester of the academic year. 2024/2025.

Figure 1Research Site

According to Sugiyono (2020) explain that variable study is a attribute or characteristic or mark from person, object or activities that have certain variations determined by the researcher for studied and then drawn conclusions.

Can concluded that variable study is a evaluation against a matter Which want to investigated so that get A conclusion. As for variable in study This, that is:

1. Variables independent or free is a variable that influences or causes changes or the emergence of dependent variables. Where the independent variable (X) is implementation model learning *Student Teams Achievement STEM-based Division* (STAD).
2. Variables dependent or bound is a variable that is influenced or that is the result of the existence of an independent variable. Where the dependent variable (Y) is *mathematical critical thinking ability*.
3. Moderator variables are variables that influence (strengthen or weaken) the relationship between independent and dependent variables. Where the moderator variable is the style of learning mathematics.

In this study, the design used was *factorial design*, this is in line with Sugiyono's opinion. (2020) which state design study experiment among them is *factorial design* . In this design, there are three groups selected randomly (R). The first and second groups are given treatment (X) and the other group is not. The group given treatment is called the experimental group and the group not given treatment is called the control group.

RESULTS AND DISCUSSION

First Hypothesis

the results of the *two-way* ANOVA test, it shows that the significance value for the learning model is $0{,}003 < 0{,}05$then H_0rejected or H_1accepted. Where it is concluded that the application of the STEM-based STAD learning model has an effect on students' critical mathematical thinking skills. As stated by Cianca (2019) who stated that the STEM-based STAD learning model has a positive effect on improving students' critical

mathematical thinking skills. This is in line with the research of Sahabudin et al. (2024) concluded that the STEM-based STAD learning model significantly improves students' critical thinking skills.

Class A as experimental class I received the STAD learning model treatment based on STEM. This learning model begins with the *orientation stage* , namely conveying learning objectives and motivation, the *apperception stage* where the teacher relates the material to student experiences. the next step is to divide groups consisting of 4-6 students who are heterogeneous. Then the teacher demonstrates trigonometry material, explains the making of clinometers, and the use of geogebra. Continued with students studying in groups and students are asked to find various information about the application of trigonometry around us that can be done, namely the *research stage* . Next, the *discovery* and *application stages* , students conduct experiments together in the field to apply trigonometry material using clinometers that have been made such as measuring the height of a flagpole. The next step is that students are asked to work on quizzes and present the results of experiments and quizzes that have been done randomly and then responded to by other groups. Then awards are given to the team and finally *closing,* namely evaluating the process and results that have been discussed. In STAD learning based on STEM which can have an effect on improving students' critical mathematical thinking skills is even better at the direct experiment stage in the field where students are asked to think critically in applying the material in real terms.

In class C as experimental class II, the STAD learning model was used. This learning model has the same stages as the stages in class A, the only difference is the presence or absence of experiments or *discovery* and *application stages* . This learning model begins by conveying learning objectives and motivation, then dividing groups consisting of 4-6 students who are heterogeneous. Then the teacher demonstrates trigonometry material. Continued with students studying in groups and students are asked to find various information about the application of trigonometry around us. The most important thing in this STAD learning step is where students teach each other and discuss the material so that all students can more easily understand the material. The next step is that students are asked to work on quizzes and present quizzes that have been done randomly and then responded to by other groups. And finally, awards are given to the team.

It is different in class D as a control class that received *direct instruction learning model treatment*. In this learning model, it begins with an orientation step, namely the teacher conveys the learning objectives, followed by the teacher demonstrating trigonometry material. Then carry out guided practice steps, namely students are asked to work on practice questions, then the teacher watches and guides students in working on practice questions. The next step is the teacher provides feedback to check student understanding. In the last step, students are asked to do independent exercises. In this *direct instruction learning*, it is very dependent on the teacher who explains the material in improving critical mathematical thinking skills.

The next thing is the provision of *a posttest* to measure mathematical critical thinking skills. As seen in appendix 16, the answer from one of the students in the class that applies the STEM-based STAD learning model shows that the student is able to make a mathematical model correctly, able to use the strategy correctly. This is in accordance with the indicators of mathematical critical thinking skills, namely interpretation, analysis, evaluation, and inference. Like wise with the answer of one of the students who applied the STAD learning model as seen in appendix 17. In addition, in the class that applies the *direct instruction learning model*, one of the students answered that he was also quite capable of writing down what is known and asked, making mathematical models, using strategies and calculations and making the right conclusions. However, there are still many students who are still unable to make mathematical models correctly and use the right strategy. When compared to the experimental class with the control class, the level of students' mathematical critical thinking skills is superior in the experimental class compared to the control class. From the research that is in line with this, the application of the STEM-Based STAD learning model in learning is feasible to improve students' mathematical critical thinking skills.

Second Hypothesis

the significance value for learning styles, it $0{,}725 < 0{,}05$is H_1rejected or H_0accepted. It is concluded that learning styles have no influence. on students' mathematical critical thinking skills. This is in line with the research of Setiawan W. Y et al. (2020) which shows that there is no influence of learning styles on students' mathematical critical thinking skills in this study. There is no difference in mathematical critical thinking skills between students who have visual and auditory learning styles, visual and kinesthetic, and auditory and kinesthetic.

Each student has their own learning style, but this does not affect students' critical mathematical thinking skills in STEM-based STAD learning, STAD learning, or *direct instruction learning*.

Third Hypothesis

the significance value, $0{,}508 > 0{,}05$it is H_1rejected or H_0accepted. It can be concluded that the application of the STAD learning model based on STEM with learning style no interaction on students' critical mathematical thinking skills.

This can be illustrated by the following plot graph:

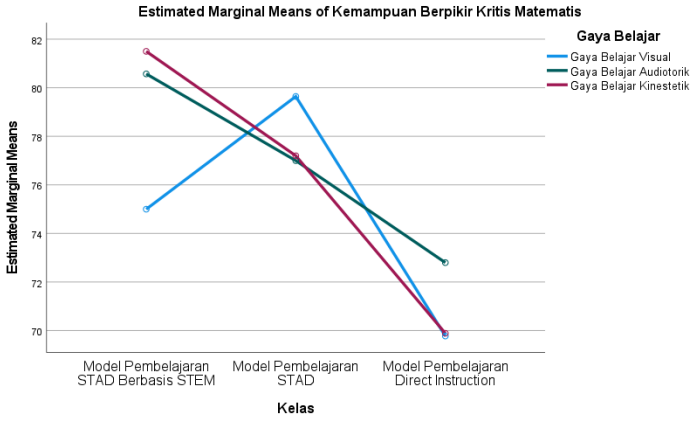

Figure 4. 1Graph Plot of Learning Models with Learning Styles

Based on the plot graph , it can be seen that there is no interaction between the STEM-based STAD learning model, STAD, and *direct instruction* with learning styles in influencing students' critical mathematical thinking skills . Therefore, learning models with learning styles do not depend on each other in influencing students' critical mathematical thinking skills.

Based on the existing explanation, it can be said that learning models and learning styles do not depend on each other in influencing students' critical mathematical thinking skills.

CONCLUSION

Student learning model *Team Achievement Division* (STAD) based on STEM on *Mathematical Critical Thinking Ability* . Based on the two-way ANOVA test, it was found that the significance value was 0,003 (< 0,05). The STAD learning model based on STEM has an effect on students' mathematical critical thinking ability because this learning syntax requires students to develop their mathematical critical thinking ability.

There is an influence of visual, auditory and kinesthetic learning styles on *Mathematical Critical Thinking Ability* . Based on the two-way ANOVA test, it was found that the significance value is 0,725 (< 0,05). Each student has a different learning style, but each student's learning style does not affect students' mathematical critical thinking abilities.

There is an interaction between the application of the *Student learning model Team Achievement Division* (STAD) based on STEM with mathematical learning styles towards *Mathematical Critical Thinking Ability* . Based on the two-way ANOVA test, it was found that the significance value was 0,508 (< 0,05). This is because effective learning models such as the STEM-based STAD learning model and in terms of learning styles cannot interact good at improving students' critical mathematical thinking skills.

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