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PENINGKATKAN KEMAMPUAN BERPIKIR STATISTIS DAN KEMANDIRIAN BELAJAR SISWA SMA DENGAN PENDEKATAN *SCAFFOLDING* BERBASIS ETNOMATEMATIKA

**Abstract**

The social constructivist perspective should be applied in mathematics learning to create an active learning process. The Scaffolding learning strategy is a supportive strategy that can enhance this process. Based on the results of the PAS (Penilaian Akhir Semester) conducted in class X, the average score of students at SMAN 1 Cikidang was 32, placing the school in the low category for statistical thinking abilities. The low level of self-regulated learning is also reflected in students' habits of neglecting to study or not completing assignments when the teacher is absent from class. This lack of self-regulation in learning contributes to the students' poor statistical thinking abilities.

The aim of this study is to examine whether there is an improvement in high school students' statistical thinking skills and self-regulated learning using the ethnomathematics-based scaffolding learning strategy. The research design is a Quasi-Experimental Design, combining both quantitative and qualitative methods (mixed method). Students' initial mathematical abilities (KAM) are used as a benchmark to group them into high, medium, and low abilities.

The results of the study show that there is an improvement in the statistical thinking skills of students who were taught using the scaffolding strategy, with these students performing better than those who received conventional instruction in the high and medium KAM groups. However, for the low KAM group, students receiving conventional instruction performed better than those taught with the scaffolding strategy. Additionally, the self-regulated learning of students using the scaffolding strategy was better than that of students receiving direct or conventional instruction. This demonstrates that the scaffolding learning strategy is more effective in improving students' statistical thinking skills and enhancing their self-regulated learning.

**Keywords:** Scaffolding, Self-regulated , Statistical Thinking.

**INTRODUCTION**

The social constructivist perspective should be applied in mathematics learning to create an active learning process. Nurhayati (2017) stated that changes in the teaching process require the significant role of teachers to guide and respond in a way that helps students develop their own thinking. Scaffolding learning is a supportive approach that can enhance this. In Indonesian, scaffolding is defined as "perancah" (scaffolding) and is described as bamboo (beams) used as support during the construction of a house. Scaffolding assists students cognitively as companions in their learning process. The interaction between teachers and students who face difficulties in the learning process is known as scaffolding. The goal of scaffolding is to improve students' understanding and skills (Mustofa et al., 2021). The purpose of the scaffolding learning process is to make it easier for students to grasp the material or practice presented by the teacher. Educators help students by providing cues, reminders, encouragement, and explanations to facilitate independent learning (Wahidin et al., 2016).

The scaffolding learning strategy relies on teacher assistance to help students learn and solve problems (Puspita & Sapir, 2012). It can be defined as a specific form of support given at the beginning of learning to facilitate learning and encourage independent learning (Nurhayati, 2017). According to Sutarmi et al. (2013), scaffolding is a learning activity related to real-world contexts to achieve goals using simple language, visual representations by the teacher, and prepared learning tools.

Lev Vygotsky was the first to introduce the concept of scaffolding. According to Hartman (2002), Vygotsky’s theory introduces social constructivism with two components: social interaction and the zone of proximal development (ZPD). Vygotsky defined scaffolding as "the role of teachers and others in supporting the learner’s development and providing support structures to reach the next stage or level" (Stufyf, 2002). In other words, scaffolding is the best method to reach the desired level. ZPD is the area between what a person can do independently and what they can achieve with assistance from adults or experts. Scaffolding is essential to reach this potential developmental level.

Byrnes (Hartman, 2001) mentioned that Vygotsky identified four phases of scaffolding learning: first, modeling through verbal explanations; second, students imitating the teacher’s modeling; third, the gradual removal of assistance; and fourth, students reaching a mastery level. In the second phase, teachers must continuously assess students' understanding and provide help as needed. In the third phase, teachers gradually reduce their assistance, much like when they begin teaching new material.

According to Roehler and Cantlon (Bikmaz et al., 2010), the following are the characteristics of scaffolding related to learning: (1) Provide explanations. These explanations consist of clear and firm statements that are adjusted to the students' understanding of the subject matter to be learned, as well as the reasons, when, and how they are used. (2) Require student participation. Learners are given the opportunity to participate in the learning process. After the instructor demonstrates the thinking, actions, and feelings that should be included in the task to be performed, students have the chance to complete it according to their knowledge and understanding. (3) Check and clarify students' understanding. If students' understanding aligns with the truth standards, the teacher reviews and tests their responses. If not, the teacher provides clarification on the correct information. (4) Demonstrating specified behavior is a learning attitude that shows how one should act, think, or feel in a given situation. One must practice thinking out loud, speaking aloud, and doing what they say. (5) Encourage students to provide suggestions, ideas, or thoughts. Learners are encouraged to offer directions, ideas, or cues about what should be done in tasks or exercises. Depending on the material to be discussed, these five features of scaffolding can be used simultaneously or individually.

In order to lay the foundation for the development of an advanced society, the characteristics of scaffolding in mathematics learning at school are fundamental. Math teachers should not merely teach abstract symbols and boring theorems to their students. By providing clear learning objectives and a realistic approach, mathematics can become a daily companion for students. Thus, mathematics should at least be integrated into students' daily lives through the teaching of local wisdom in the environment where they study. Ethnomathematics is a type of mathematics learning that uses local wisdom. Mathematics that is influenced or based on a particular culture is referred to as ethnomathematics. Ilma & Putri (2020) state that "ethnomathematics is defined as a field that studies efforts made by individuals due to cultural differences, with the aim of examining, articulating, and applying concepts related to the relationship between culture and mathematics." Therefore, ethnomathematics can be defined as cultural anthropology related to mathematics and its education (Zhang et al., 2021). The learning environment in ethnomathematics-based education should be made enjoyable for both teachers and students. This allows both teachers and students to actively participate in the culture they are already familiar with, achieving optimal learning outcomes (Fahrurrozi, 2015).

Ethnomathematics is a type of mathematics that is based on or influenced by culture. By incorporating ethnomathematics into mathematics education, it is hoped that students will better understand both mathematics and their own culture. Thus, educators will find it easier to instill cultural values, which are part of the nation’s character, in students from a young age (Wahyuni et al., 2013).

Students will find it easier to comprehend subject matter if culture is incorporated into learning. Statistics is a field of knowledge that can be used to interpret and understand the phenomenon of uncertainty, which continually occurs in science, life, and the workplace (Moore, 1997; Yusuf, 2017). Specifically, statistics is used to describe and predict phenomena using a set of measured results. Therefore, the goals of statistics learning must be supported by learning experiences, teaching materials, and instructional media. According to Rumsey (2002), the goal of statistics education is to provide students with a strong understanding of statistics so that they can comprehend how to use data, critique and make decisions based on their understanding, and develop research skills. Thus, statistical reasoning is essential.

Ulpah (2013) stated that statistics instruction needs to be transformed to enhance students' statistical reasoning abilities. First, the perspective on teaching knowledge is defined as the relationship between concepts and reasoning procedures. Second, learning is no longer seen as an individual effort to master processes explained by the teacher but rather as a collaborative effort to acquire knowledge. Third, teaching shifts from structured instruction, explaining lessons, and correcting student errors to teaching through interaction. According to several studies, most students memorize formulas and procedures or steps provided without first understanding the concepts. As a result, they become unprepared and confused when faced with problems designed differently from what they are accustomed to (Setyorini et al., 2017).

Self-regulated learning is a component that influences students' statistical abilities. Self-regulated learning helps students solve mathematical problems more effectively. Students with a high degree of self-regulated learning can: a) save time in completing tasks, b) learn better under their own supervision than under a programmed one, and c) effectively organize and monitor their learning and time. According to Pratiwi & Laksmiwati (2016), confidence in one's ability is one of the characteristics of individuals with self-regulated learning. One component of self-confidence is belief. Those who are confident in their abilities think positively about their capacity to solve various learning problems.

Based on the results of the PAS (Penilaian Akhir Semester) conducted in class X at SMAN 1 Cikidang, the average score obtained by students was 32, indicating that the statistical thinking abilities of the class X students at SMAN 1 Cikidang fall into the low category. The low level of self-regulated learning is also evident from students' habits of neglecting to study or not completing assignments given by the teacher when absent from class. This lack of self-regulation in learning contributes to the students' inadequate statistical thinking abilities.

This aligns with the findings of Fasa et al. (2021), which suggest that students who have an awareness of independent learning are better able to receive information from teachers compared to those without such awareness. Those who lack this awareness struggle more to receive information from teachers, and this impacts the quality of learning outcomes. Therefore, the research to be conducted is titled "Improving Statistical Thinking Skills and Self-Regulated Learning in High School Students Through Scaffolding Strategies Based on Ethnomathematics."

**METHOD**

The research design is a Quasi-Experimental Design. This study is a mixed-method research, combining both quantitative and qualitative approaches. The quantitative aspect of this research is a quasi-experimental study, as the subjects for the experimental and control classes were not randomly selected, but rather the researcher accepted the subjects as they were (Ruseffendi, 2005). The quasi-experimental design applied in this study uses a pretest-posttest design. The research design is as follows:

0 X 0

 0 0

Explanation:
0 = Pretest and posttest (test of mathematical connection ability)
X = Treatment using the Scaffolding method based on ethnomathematics
-- = Subjects were not randomly grouped

The design of this research aligns with the aim of the study, which is to determine whether the ethnomathematics-based scaffolding learning method can improve high school students' statistical thinking abilities and their learning independence in mathematics. In the learning implementation, the experimental class used the ethnomathematics-based scaffolding learning method, while the control group used conventional learning. The topics, reference books, and learning aids used were relatively the same. A pre-test was given before the learning began, and a post-test was administered after all the learning activities were completed.

The research design is a mixed-methods study, utilizing the **Embedded Design**. According to Indrawan and Yaniawati (2017), this method strengthens the research process by incorporating both qualitative and quantitative approaches. Embedding is applied in areas that require reinforcement or clarification, ensuring that the conclusions drawn have a higher degree of confidence in understanding. This design was used because the researcher aimed to perform triangulation, or compare and connect findings from both types of data.

The population of this study consists of all tenth-grade students at SMA 1 Cikidang, Sukabumi Regency. From this population, since it was not feasible to form new classes from random samples, two classes out of the 10 available were chosen as the sample subjects based on the research design. The sampling was conducted using purposive sampling, a technique in which the sample is selected based on specific considerations (Sugiyono, 2010: 25). One of the classes selected as the experimental group was Class X6, consisting of 30 students, while another class, Class X10, was selected as the control group, also with 30 students.

Given that the study aimed to investigate statistical reasoning, the chosen subject matter for the study was statistics, which is taught in the second semester of tenth grade. The rationale behind selecting tenth-grade students is that, according to Piaget & Inhelder (2010), high school students are already capable of abstract thinking based on certain logical frameworks. Students can reason using more symbols or ideas in their thinking process. This is the reason why Class X6 and X10 were chosen, with Class X6 serving as the experimental group. Another reason for selecting Class X6 and X10 is that their average daily test scores were very similar. Class X6 had an average score of 5.4, while Class X10 had an average score of 5.3.

The determination of high, medium, and low levels for each selected class was based on criteria proposed by Arikunto (2002) as follows: students at the high level are those with scores greater than or equal to x̅+s; students at the medium level are those with scores less than x̅+s but greater than or equal to x̅-s; while students at the low level are those with scores less than x̅-s, where x̅ and s are the mean and standard deviation of all students from both classes selected as the sample.

**RESULTS AND DISCUSSION**

The improvement of students' statistical thinking abilities is measured using the N-Gain of students' statistical thinking skills, both in the experimental class and the control class. To determine the direct effect and the interaction effect between the learning approach factor and prior mathematical knowledge (KAM) on the improvement of students' statistical thinking abilities, a two-way analysis of variance (ANOVA) will be used. The condition for using two-way ANOVA is that the data on the improvement of students' statistical thinking abilities must be normally distributed, thus the two-way ANOVA test is applied.

**Normality Test**

The data used for this test is the N-Gain of statistical thinking abilities in the experimental and control classes. If at least one data point is not normally distributed, then data analysis will be carried out qualitatively by examining the profile plots of the estimated marginal meansgraph.
The hypothesis for the normality test of N-Gain data distribution is as follows:

* H0: The N-Gain data of students' statistical thinking abilities are normally distributed.
* H1: The N-Gain data of students' statistical thinking abilities are not normally distributed.

With the testing criteria: reject H0 if the Sig. value is less than ∝ = 0.05. The results of the normality test for the N-Gain of students' statistical thinking abilities are presented in Table 1

Table 1

**Tests of Normality**

|  |  |
| --- | --- |
| Kolmogorov-Smirnova | Shapiro-Wilk |
| Statistic | df | Sig. | Statistic |
| .056 | 60 | .200\* | .989 |

From the table, it can be seen that the Sig. value from the test is 0.871, which is greater than the significance level of ∝ = 0.05, meaning H0 is accepted. This indicates that the data follows a normal distribution. Next, we will conduct a homogeneity test.

**Homogeneity Test**
The homogeneity test is conducted to examine the variance of statistical thinking ability data based on the N-Gain values. The hypotheses for the homogeneity test of the N-Gain score variance of students' statistical thinking abilities based on low prior mathematical knowledge (KAM) in the experimental and control classes are as follows:

* H0: The variances of the two classes are homogeneous.
* H1: The variances of the two classes are not homogeneous.

The testing criteria are to accept H0 if the Sig. (2-tailed) value of Levene's test is greater than the significance level of ∝ = 0.05 and to reject H0 for other values. The results of the homogeneity test for the N-Gain of statistical thinking ability for low KAM students between the experimental and control classes are presented in the table 2

Table 2

|  |
| --- |
| **Test of Homogeneity of Variance** |
|  | Levene Statistic | df1 | df2 | Sig. |
| Nilai  | Based on Mean | 2.808 | 5 | 54 | .025 |

Based on the data in Table 2, the Sig. value of Levene's Statistics for the experimental and control classes is less than ∝ = 0.05, so H0 is rejected. This indicates that the N-Gain data of statistical thinking abilities based on KAM between students who received scaffolding learning and those who received conventional learning is not homogeneous.

**Mean Test**

Based on the results of the normality and homogeneity tests, the N-Gain data of statistical thinking abilities based on KAM were found to be normally distributed but not homogeneous. Therefore, to test the interaction between the learning approach factor and KAM on the improvement of students' statistical thinking abilities based on KAM, a two-way ANOVA test is conducted with a significance level of 0.05. The research hypothesis being tested is that there is a significant interaction effect between the learning approach factor and KAM on students' statistical thinking abilities.

* H0: There is no significant interaction effect between the learning approach factor and KAM on students' statistical thinking abilities.
* H1: There is a significant interaction effect between the learning approach factor and KAM on students' statistical thinking abilities.

The decision-making criterion for the above hypothesis is to look at the 2-tailed significance value. If the Sig. (2-tailed) value < ∝ (∝ = 0.05), then H0 is rejected. If the Sig. (2-tailed) value ≥ ∝ (∝ = 0.05), then H0 is accepted. The results of the ANOVA test for the N-Gain data on students' statistical thinking abilities based on KAM are presented in Table 3

|  |
| --- |
| **Table 3****Tests of Between-Subjects Effects** |
| Dependent Variable: Nilai |
| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
| Corrected Model | 3359.029a | 5 | 671.806 | 7.118 | .000 |
| Intercept | 270992.199 | 1 | 270992.199 | 2871.259 | .000 |
| KAM | 348.886 | 2 | 174.443 | 1.848 | .167 |
| Kelas | 2325.746 | 1 | 2325.746 | 24.642 | .000 |
| KAM \* Kelas | 753.076 | 2 | 376.538 | 3.990 | .024 |
| Error | 5096.571 | 54 | 94.381 |  |  |
| Total | 304138.000 | 60 |  |  |  |
| Corrected Total | 8455.600 | 59 |  |  |  |
| a. R Squared = ,397 (Adjusted R Squared = ,341) |

Based on Table 3, the significance value for the learning approach with KAM is smaller than ∝ = 0.05, so it can be concluded that H0 is rejected. This means that there is a significant interaction effect between the learning approach factor and KAM on students' statistical thinking abilities.

From the previous analysis of the mean N-Gain from the high, medium, and low KAM groups, it can be concluded that the improvement in statistical thinking abilities of students who received scaffolding learning is higher than those who received conventional learning in the high and medium KAM groups, while for the low KAM group, students who received conventional learning showed higher improvement than those who received scaffolding learning.

Therefore, it can be concluded that there is an interaction effect between the learning approach factor and KAM on the improvement of students' statistical thinking abilities using the scaffolding approach.

Based on the analysis, it was found that the effectiveness of the ethnomathematics-based scaffolding learning strategy on students' statistical thinking abilities and learning independence has a high impact. This proves that the ethnomathematics-based scaffolding learning strategy is more effective and can be used in mathematics learning, as it can better accommodate students' learning needs. This is in line with research conducted by Murod (2019), which showed that the improvement in statistical thinking abilities of students who received the scaffolding learning strategy was significantly higher than that of students who received the direct approach, both overall and based on their initial abilities

**CONCLUSIONS**

Based on the research findings and the discussion in the previous chapter regarding the improvement of statistical thinking abilities between students who received mathematics instruction using scaffolding learning strategies and conventional methods, the following conclusions were drawn:

1. Learning activities that used scaffolding strategies, where students connected mathematical concepts with local culture, traditions, and daily activities, showed that students were more active in solving the given problems. By relating cultural contexts to the material being studied, students found it easier to understand the solution patterns of each problem they encountered.
2. To assess the improvement in students' statistical thinking abilities, the research began by examining the initial mathematical abilities of both the experimental and control classes, and the results showed no difference between the two, meaning both classes had the same initial mathematical abilities. This initial ability was used to group students into high, medium, and low ability levels. The improvement in statistical thinking abilities after students received scaffolding learning showed significant progress in the high and medium KAM (prior mathematical knowledge) groups, where student learning mastery surpassed the minimum mastery criteria at these levels. However, in the low KAM group, there was no improvement in statistical thinking abilities. This was due to the common habit in the low group of not asking questions to the teacher, waiting for the answers from classmates with higher abilities, and lacking the motivation to solve the given problems. As a result, the learning process was not optimal, even though the teacher provided full guidance.
3. The results of student independence showed that those who received the scaffolding learning strategy performed better than those who received conventional learning. Students who were taught using the scaffolding strategy exhibited better learning independence compared to those in conventional learning, which made them more active and enthusiastic in solving the problems assigned by the teacher.
4. The effectiveness of the scaffolding learning strategy was rated as highly effective. This indicates that the ethnomathematics-based scaffolding learning strategy was very effective and successful in helping to improve students' statistical thinking abilities.

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