



The analysis of adaptive reasoning ability reviewed from students' confidence in ethnomathematic-based treffinger learning model

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Abstract

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The objective of this study was to examine whether ethnomathematics-based Treffinger learning model was good to improve students' adaptive reasoning ability and to describe the adaptive reasoning ability based on students' self-confidence level. The method of this study was Mixed Methods. While the population of this study was tenth grade science students of Wiradesa High School academic year 2017/2018. Again, the population was divided into 2 categories, they were the tenth grade of Science 2 was the experimental class and the tenth grade Science 1 was a control class. Eventually, the result showed that: (1) Ethnomathematics-based Treffinger learning model has good quality in improving students' adaptive reasoning ability since the planning and the implementation of learning process had good criteria, starting from teacher's and student's activities and the average of learning outcomes had reached the minimum score (KKM) and (2) the classification of adaptive reasoning ability was based on students' confidence level.

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Introduction

According to the National Council of Teachers of Mathematics or NCTM (2003), the purpose of mathematics learning is students must learn mathematics through active understanding to get new experiences and knowledge. Again, NCTM has also mentioned five basic standards that must be mastered by students in order to reach the goals of mathematics learning, as follows: (1) problem solving, (2) reasoning and verification, (3) communication, (4) connection, and (5) representation. Again, NCTM (2003) highlights that mathematics reasoning and verification are the strong keys to develop and express insight into various phenomena.

In line with Kilpatrick (2001) who explains that student must have mathematical skills which are as follows, (1) conceptual understanding which means that students' understanding or mastery on concepts, operations, and mathematical relations, (2) procedural fluency which refers to knowledge of procedures, when and how to use them

appropriately, and the skill to perform the procedures in a flexible, accurate and efficient manner, (3) strategic competence which refers to the ability to formulate, present, and solve mathematical problems, (4) adaptive reasoning covers the ability to think logically about the relationship between concepts and situations and to provide truth, (5) productive disposition which is the tendency to have productive habit to see mathematics as sensible, useful, meaningful, valuable, and has confidence as well as perseverance in learning mathematics.

According to Wibowo (2016: 240), there are several indicators of adaptive reasoning namely (1) submitting a presumption; (2) providing reasons for the given answers; (3) drawing conclusions from a statement; (4) checking the validity of an argument; and (5) finding patterns of a mathematical problem. However, in this study, the five indicators had been modified into four indicators namely (1) submitting a presumption; (2) checking the validity of an argument by giving reasons for the given answers; (3) finding patterns

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of a mathematical problem; and (4) drawing conclusions from a statement.

When developing mathematical ability in learning activity, it goes without saying that every teacher will face different characteristics of students. One of them is confidence. Self-confidence is being certain of students' abilities and efforts then they are able to do what they want and to achieve the expected mathematics learning goals of mathematics (Warda, et al, 2017: 315). Self-confidence also delivers good thoughts and directed activities.

Further, based on the interview results with a mathematics teacher at Wiradesa State Senior High School shows that during the learning process, students assumed that they had well understood the material explained. On the contrary, they are passive to deliver a question. For more, they still get difficulties in finding a solution of the given questions. Though they have difficulties in finding the patterns and generalization. This finding is proven from one of student's work on squared root material.

$$3) 2\sqrt{20} + \sqrt{28} - 3\sqrt{125} + 4\sqrt{63} - 5\sqrt{80} = \\ 2\sqrt{4.5} + \sqrt{7.4} - 3\sqrt{25.5} + 4\sqrt{9.7} - \dots$$

At learning process, student had been taught how to simplify the root form. The result of his work shows that he was able to find the pattern of the root form by simplifying the numbers. However, he did not complete the pattern of $5\sqrt{80}$ well. Owing to that fact, it can be concluded that they are still confused to operate it. Consequently, they are stuck in finding the pattern. They have not mastered the adaptive reasoning indicator that is finding a pattern of mathematical symptoms. Above all, the adaptive reasoning ability becomes very important for students especially in solving reasoning problems.

Afterwards, the ability of adaptive reasoning of Wiradesa State Senior High School students also can be seen from the results of early tests which has been conducted by researcher. The experimental class students were given a pretest to measure adaptive reasoning ability with inverse function material. Based on the preliminary test, the average adaptive reasoning ability of students reach 50.2.

Regarding to preliminary finding, it is necessary to have a learning strategy that can be applied to foster students' adaptive reasoning ability, one of them is Treffinger learning model. It can help students in mastering the concepts of material given by the teacher, as well as providing

opportunities for students to explore so that they are able to demonstrate their potential abilities including reasoning ability. According to Sarson in Huda (2014), the most dominant characteristic of Treffinger learning model is involved two aspects namely cognitive and affective in each steps of this learning model. Thus, Treffinger learning model is expected being able to foster students' adaptive reasoning ability.

Along with the development of science and technology, student awareness of local culture has been decreased. According to Wahyuni (2013), modernization is the cause of the erosion of the nation's cultural values due to lack of application and understanding of the importance of cultural values in society as well the lack of insertion or understanding of local culture in classroom learning, so that they do not appreciate the culture that exists and grows in their surrounding. Further, one of culture-based learning is ethnomathematics. According to Fitriati (2016: 4), ethnomathematics-based learning can be implemented into formal mathematics learning in order to overcome the difficulties of learning mathematics for students and introduce local culture in their environment. The role of the teacher in formal learning activities can be done by providing contextual meaning which is relevant to the mathematics learning material given to students and must be integrated with the cultural values that exist in the student's living environment.

Based on the explanation above, there are several objectives of this study, as follows, (1) to test the quality of Treffinger learning ethnomathematics-based to improve students' adaptive reasoning ability by (a) testing students' adaptive reasoning skill on Treffinger models ethnomathematics-based to achieve the average and classical completeness; (b) testing the improvement of students' adaptive reasoning ability after learning with Treffinger learning ethnomathematics-based model; and (c) testing whether the adaptive reasoning ability of students by Treffinger learning model is better than by Problem Based Learning model (2) to describe students' adaptive reasoning ability through the implementation of Treffinger based on ethnomathematics learning in terms of their confidence.

Research Methods

This study used a combination method with the Sequential Explanatory model. Firstly the data were collected by using quantitative method, after that analyzed by using qualitative method. According to Sugiyono (2015: 415), quantitative method were used to obtain quantitative data which were measurable and descriptive, comparative, and associative. While the qualitative method is used to prove, deepen, expand, weaken, and abort quantitative data which were obtained in the first stage. The design of quantitative research was in the form of Posttest-Only Control Design. The subject of this study was divided into 2 groups namely experimental and control class.

Then, the population of this study was students of tenth grade science Wiradesa Senior High School in academic year 2017/2018. Two classes were selected purposively, they were tenth science 2 as the experimental class and tenth science 1 as the control class. Whereas qualitative research described the ability of adaptive reasoning based on students' confidence with the research subjects consisting of 6 students, namely 2 subjects of high self-confidence category, 2 subjects with medium category, and 2 subjects with low category.

Additionally, quantitative data analysis was divided into two parts, namely initial and final data analysis. The initial data analysis was taken from the preliminary test of adaptive reasoning ability which aimed to know both classes came from the same initial condition and to find out the students' initial abilities. The final data were taken from the results of the students' adaptive reasoning ability which aimed to find out the classical completeness, improvement, and similarity of the two proportions. While the qualitative data analysis was conducted through three main steps, namely data reduction, data presentation, and conclusions. For more, the data collection technique which was used in this study covered the pretest of adaptive reasoning ability, posttest adaptive reasoning ability, confidence scale, documentation, interviews, and observation. The instruments used have been validated by experts, namely supervisors and teachers at Wiradesa Public High School. The instruments used are preliminary tests of adaptive reasoning ability, posttest adaptive reasoning ability, confidence scale, observation sheets, and interview guidelines. The posttest instrument was tested in tenth science 5, then analyzed the validity, reliability, distinguishing

power, and level of difficulty so that the posttest questions were feasible to use.

Results & Discussions

Based on the early test result from experimental class and control class, it shows that the two classes came from populations which were normally distributed, their variances were homogeneous, and had the same average. The final data were obtained from the post test results of the two classes which had been given treatment first; the experimental class with ethnomathematics-based Treffinger learning model and PBL learning model for the control class.

Results and Discussion of Quantitative Research

The quantitative research data which are tested by hypotheses test need to be prerequisite test first. Initially, the normality test was carried out with the Kolmogorov-Smirnov test assisted by SPSS 16.0. The results of the posttest experimental and the control class were normally distributed. While the homogeneity test was carried out by using the Levene test which noted that the two homogeneous classes had the same variant.

The pretest and posttest of the experimental and control class are presented in table 1.

The Pretest and Posttest Results of Experimental Class and Control Class

Group	Type Test	
	Preliminary Tests	Posttest
Experiment	50,2	84,2
Control	43,7	73,2

The first Hypothesis test is used to test adaptive reasoning ability in class which used Ethnomathematics-based Treffinger learning model to achieve classical completeness. The test was the average test which was to test the average posttest results of the experimental class more than 70 and the proportion of one part to test the number of students in the experimental class which was more than 75% complete. Based on the result of the average calculation test, it shows that $t_{count} = 7,7272$ and $t_{table} = t_{(0,95)(29)} = 1,699$ with $\alpha = 5\%$. Since $t_{count} > t_{table}$, so H_0 is rejected. In other words, the average posttest results of adaptive reasoning ability in Treffinger learning model ethnomathematics based class is more than 70. So the average posttest results of

class using Treffinger learning models based on ethnomathematics have reached the minimum criteria. From the proportion test result, it notes that $z_{count} = 2,741$ and $z_{table} = 1,64$ so $z_{count} > z_{table}$ then H_0 is rejected. It means that many students who have achieved the completeness of the adaptive reasoning test results in were 75% of all students in the experimental class. In other words, the Ethnomathematics-based Treffinger learning model class has fulfilled classical learning completeness.

The second hypothesis test was used to determine the magnitude of the improvement of students' adaptive reasoning ability after being given Treffinger learning model based on ethnomathematics. After that, the normalized Gain test was performed. From the calculation of normalized Gain test, it shows that the improvement of adaptive reasoning ability of students after being given treatment is 0.68, this score is included in the interval $0,3 \leq (g) < 0,7$. In other words, the improvement of students' adaptive reasoning ability in Ethnomathematics-based Treffinger learning model class included in the medium category.

The third hypothesis test was used to determine that the adaptive reasoning ability of students with Treffinger learning models based on ethnomathematics was more than the students with PBL learning models. This hypothesis used parametric statistics which was to test the two average differences and the difference of two proportions. Based on the results of the average two difference test, it shows that $t_{count} = 4.05152$ and $t_{table} = t_{(1-\alpha)(dk)} = t_{(0,95)(58)} = 1,672$ so H_0 was rejected. It means that the average adaptive reasoning ability of students in Treffinger learning models ethnomathematics-based class was more students' in PBL learning model class. From the calculation of the two proportions difference test, it reports that $z_{count} = 3.0033$ and $z_{table} = z_{(0,45)} = 1.64$ with $\alpha = 5\%$, so H_0 that was rejected. It means that the proportion of Treffinger's learning model based on ethnomathematics student was more than PBL learning model students.

Furthermore, the quality of learning can be seen from the planning of the learning process or called as RPP validation. The RPP validation result which has score of 3.76 means that the lesson plan used during the study has good criteria. Then, the implementation of the learning process can be seen through the activities of teachers and students. The assessment of the implementation of

the learning process in the experimental class was carried out by high school teachers in which the teacher was the observer in the implementation of learning. From 3 meetings, the average teachers' activity in the implementation of the learning model was 84.9% which was very good. By the same token, the average of students' activity in Treffinger ethnomathematics-based learning is 81.6 which included in very good criteria.

Based on the result of the final data analysis, it reports that: (1) the ability of adaptive reasoning on Treffinger learning model ethnomathematics-based has achieved the average and classical completeness; (2) there is an increase in adaptive reasoning ability in experimental class students before and after being given learning with ethnomathematics-based Treffinger learning model ; and (3) the adaptive reasoning ability of Treffinger's ethnomathematics-based learning model class is better than in PBL learning model class.

The quality of ethnomathematics-based Treffinger learning model in improving adaptive reasoning ability is in accordance with the results of Dawes's (2012) research which explains that the process of learning mathematics with Treffinger learning model leads to the formation of mathematical reasoning abilities that make students will be able to solve problems faced, explain the results completion by explaining in front of the class, and conclude the learning outcomes. In addition, Treffinger's learning model is one of the learning that involves students' activeness. As Samuelsson (2010) states that there is a significant difference between a conventional learning and learning that involves students' activeness to enhance conceptual understanding, strategic competence and adaptive reasoning.

The results of this study are in accordance with Prihandani's study (2015). She explains about Treffinger learning with Javanese cultural is also able to foster creativity in solving problems. However, this study focuses on adaptive reasoning. Again, this study is also in line with Nisa's study (2011) which talks about Treffinger learning to enhancing students' creativity ability in solving mathematical problems. Nevertheless, this research focuses on adaptive reasoning abilities while Nisa's focuses creative ability.

Results and discussion of qualitative research

The qualitative data in this study were analyzed by using three main steps namely data reduction, data presentation, and conclusions. Data reduction was done by correcting the results of the posttest, analyzing the results of the confidence scale, and selecting the research subject for interview. Then the interview was conducted to find out how the students' adaptive reasoning abilities viewed from the students' confidence.

The ability of adaptive reasoning in this study is adaptive reasoning ability in working on problems with several indicators. They are (1) proposing allegations, (2) checking the validity of an argument by giving reasons for the answers given, (3) finding patterns of mathematical symptoms, and (4) drawing conclusions from a statement.

Based on the results of the confidence scale with 25 statements from 30 students, there were 2 students with high confidence, 25 students with moderate confidence, and 3 students with low self-confidence. After getting 6 subjects, a re-check

was conducted to see whether these 6 subjects were correct in the right group classification through consultation with the mathematics teacher. Besides, it was also seen during the continuity of learning in the classroom. Table 2 presents the research subjects from high, medium and low self-confidence groups.

Subject Research

No.	Subject	Code	Category
1.	S-1	E-013	High Confidence
2.	S-2	E-011	High Confidence
3.	S-3	E-015	Moderate Confidence
4.	S-4	E-023	Moderate Confidence
5.	S-5	E-025	Low Confidence
6.	S-6	E-008	Low Confidence

Next, the results of adaptive reasoning ability analysis in terms of students' confidence in tenth grade science 2 of Wiradesa State High School can be seen in Table 3.

Adaptive Reasoning Ability at Each Each Confident Category	High Confidence	Medium Confidence	Low Confidence
Indicators	High Confidence	Medium Confidence	Low Confidence
Asking allegations.	Being able to submit allegations which were correct and appropriate to the situation	Being less able to submit a complete allegation with reasons and suggestions in solving problems.	Being less able to submit allegations that were appropriate to the situation, complete with reasons and suggestions for solving problems.
Indicators	High Confidence	Medium Confidence	Low Confidence
Checking the validity of an argument by giving reasons for the answers given.	Being able to check the validity of an argument by using a formula that was previously suspected by giving reasons for the answer given.	Being able to check the validity of an argument by using a formula that has been suspected by giving reasons for the answers given.	Being able to check the validity of an argument by using a formula that has been suspected by giving reasons for the answers given.
Finding patterns of mathematical symptoms.	Being able to find patterns of mathematical symptoms that exist in the problem correctly and generalize it to gain the reason.	Being able to find patterns of mathematical symptoms that exist in the problem correctly and able to generalize it so that the results of the completion are obtained	Not being able to find patterns of mathematical symptoms that exist in the problem correctly so that it is wrong to generalize and get the results of a less precise resolution.
Drawing conclusions from a statement.	Being able to draw conclusions from the results of the work done is related to the questions that exist in the problem.	Being able to draw conclusions from the results of his work is related to the questions in the problem.	Being less able to draw conclusions from the results of the work associated with the questions that exist in the problem.

Based on Table 3 it can be concluded that (1) high self-confidence students were able to solve problems related to adaptive reasoning according to indicators, (2) medium self-confidence students are able to solve problems related to adaptive reasoning by mastering three indicators, while (3) low self-confidence students are able only in one indicator that is checking the validity of an argument by giving reasons regarding the answers given.

In terms of confidence, the results of this study are in line Herniyati's study (2017) which explains that high self-confidence students are able to master all indicators of adaptive reasoning, namely submitting allegations, giving reasons for the answers given, drawing conclusions from a statement, checking the validity of an argument, and finding patterns of a mathematical phenomenon. Although high self-confidence students still have difficulties in finding patterns of a mathematical phenomenon. Then, medium self-confidence students who have not been able to master all indicators of adaptive reasoning, students can only master four indicators. Whereas students with low self-confidence are only able to master three indicators, which is to put forward allegations, provide reasons for what is given, and draw conclusions from a statement. However, Herniyati's research uses five indicators of adaptive reasoning ability, while this study only used four indicators.

Again, this finding is also in line with Achdiyat & Lestari's (2016) research on mathematics learning achievement in terms of students' self-confidence and activeness in class. The study reports that there is a positive influence of students' self-confidence in the classroom on mathematics learning achievement. Where students who have high self-confidence are able to achieve good learning achievement. On the contrary, the mathematical learning achievement of low self-confidence students tends to be low. Above all, this study the mathematics learning achievement focuses on adaptive reasoning abilities.

Also, this finding is relevant with Subekti & Kusuma's 2016 study which mentions that the description of mathematical communication skills in terms of student self-confidence shows that the students with low self-confidence have not been able to present data in the form of diagrams which are in accordance with their objectives, but they have been able to present a single data into the frequency distribution table. The middle self-

confidence student are already able to present data in the form of diagrams in accordance with the objectives and frequency distribution table of a single data. While the high self-confidence students tend to be able to present data in the form of diagrams in accordance with their objectives and frequency distribution tables of single data and frequency histograms. However, difference in Subekti & Kusuma's research and this study is their study focuses on mathematical communication skills while in this study emphasizes adaptive reasoning ability.

As Setyaningrum (2017) suggests that self-confidence influences students' mathematical reasoning abilities. She says that students with high self-confidence will be not afraid to make mistakes since they can easily understand the problem and determine the direction of completion. Unlike students who have low self-confidence, they experience difficulties in understanding the problem and lack of confidence in determining the direction of completion. Nevertheless, Setyaningrum's research focuses on mathematical reasoning ability while this study emphasize on adaptive reasoning ability.

Conclusion

Based on the description of the analysis, there are several conclusion which can be drawn, they are as follows:

- (1) Treffinger learning model based on ethnomathematics has good quality in improving students' adaptive reasoning abilities. It is indicated by the planning of the learning process seeing from the RPP validation results which reports that the lesson plans used for learning during the study have good criteria. The assessment of the implementation of the learning process in the experimental class is viewed from the average. Further, the teacher's activity in the implementation of the learning model has very good criteri as well as the average student activity in Treffinger learning based on ethnomathematics. These are proven through:
 - (a) The results of the adaptive reasoning ability test using Treffinger learning model based on ethnomathematics achieve average and classical completeness;
 - (b) The adaptive reasoning ability of students has increased after being given learning

with Treffinger learning models based on ethnomathematics; and

- (c) The adaptive reasoning ability of students who learn using Treffinger learning models based on ethnomathematics is better than the adaptive reasoning ability of students who use PBL learning models.
- (2) The description of students' adaptive reasoning abilities through the implementation of Treffinger learning based on ethnomathematics in terms of students' self confidence is as follows:
- (a) The confidence results of grade X Science 2 students at Wiradesa State High School are divided into three levels, high, moderate, and low.
- (b) Students with high self-confidence tend to be able to meet four indicators of adaptive reasoning ability that is able to put forward allegations, check the validity of an argument by giving reasons regarding the answers given, find patterns of mathematical symptoms, and draw conclusions from a statement;
- (c) Students with moderate self-confidence are able to meet only three indicators of adaptive reasoning ability, namely being able to check the validity of an argument by giving reasons for the answers given, find patterns of mathematical symptoms, and draw conclusions from a statement. However, they tend to be less able to submit allegations correctly.
- (d) Students with low self-confidence are able to fulfill only one indicator of adaptive reasoning ability, namely checking the validity of an argument by giving reasons for the answers given. They are less able to guess precisely so that the work process and drawing conclusions are also not appropriate.

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