



Analysis of Mathematical Connection Ability Based on Student Characteristics Thinking on Discovery Learning Scientific Approach

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Abstract

Student's mathematical connections ability at SMK Syubbanul Wathon Tegalrejo Magelang is still low. Students are not able to relate concepts in, link the mathematical concepts to other subjects, and to problems in daily life. The study aims to describe the process of discovery learning model with scientific approach, find out the effectiveness of discovery learning of scientific approach to the student's mathematical connection ability, and to describe the mathematical connection ability of XII graders of SMK Syubbanul Wathon on differential functions based on the characteristics of student's way of thinking. This study used mixed method of concurrent embedded design. The sample was chosen by random sampling, XII-G3 (control class, XII-G4 (experiment class 1), and XII-G6 (experiment class 2) as quantitative data sources. Meanwhile, for the source of qualitative data, it was obtained by taking two CS students, two AS students, two CR students, two AR students. The result of the research shows that (1) the discovery learning scientific approach process in improving the students' mathematical connection ability is good, (2) the discovery learning model with the scientific approach is effective, and (3) The characteristics student's way of thinking also affects the students' mathematical connections ability.

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INTRODUCTION

Freudental in Soewandi (2005: 24) states that mathematics is a human activity. According to Suherman (2003: 15) mathematics is a language of symbols, numerical languages, languages that can eliminate the nature of blurring, the method of logical thinking, the means of thinking, the logic of adults, the means and the servant, the science of quantity and quantity, pure formal science, the science of numbers and spaces, study patterns (relationships, forms, and structures), abstract and deductive science, and human activity.

Prasetyo (2017) states that the ability of mathematical connections is one of the basic skills of mathematics. According to Apipah (2017), One of the important skills student's have is the ability of mathematical connections because it enables students to connect the materials. Students can understand the mathematical concepts they learn because they have mastered the prerequisite materials related to everyday life. NCTM (2000: 64) states that mathematics is not a set of disparate topics and abilities, although, in reality, math lessons are often partitioned and taught in several branches. Mathematical connection is a skill that must be built and learned as good mathematical connection ability, will help students to know the relationship of various mathematical concepts and apply them in daily life (Siagian, 2016).

In addition, Rohendi and Dulpaja (2013) state that students' mathematical connection ability is one of the most important and useful learning objectives for students because students are required to connect various topics in mathematics, link mathematics with other educational disciplines and connect mathematics with daily life. There are three levels in creating mathematical connections: inter-concepts of mathematics, mathematical concepts in relation with other diciplines, and with the context of daily life (Zevenbergen et al, 2004: 115-116).

Kholiqowati (2016) states that every learner has a distinctive way of thinking. Characteristics of ways of thinking affect the process of internal representation of learners. This learners' way of thinking influences the learner's success in solving mathematical problems in his own way from the abilities he possesses in his thinking. The students in the learning process have characteristics of different ways of thinking. The development of one's thinking moves from concrete activities to abstract thinking (Herlina et al, 2016).

According to Sardiman (1990: 118), the characteristics of students is the overall pattern of behavior and abilities that exist in the students as a result of innate and social environment, therefore, it determines the pattern of activity in achieving its goals. According to Sujanto (2001: 56) think is the power of one's soul that can put relationships between knowledge possessed. De Porter and Hernacki (1999: 128-135) divide the types of thinking characteristics into four, they are concrete sequential type (CS), abstract sequential type (AS), abstract random type (AR), and concrete random type (CR).

In developing the ability of mathematical connection required a learning model. The accuracy of the mathematical learning model is useful in constructing new concepts and developing them on other mathematical material topics or with other disciplines (Rodiawati, 2016). According Joolingen in Mawaddah (2015), discovery learning is a learning where students build their own knowledge by experimenting, and making conclusions of rules / concepts from the results of his experiments. The basic idea of this learning is that students can design their own experiments and conclude their own rules / concepts so they really build on their knowledge.

Fitriyantoro (2016) states that the scientific approach in the learning in question is a series of learning activities that include observing, questioning, gathering information, associating, and communicating. According to Kemendikbud (2013), the scientific approach in such learning involves observing, asking, reasoning, trying, forming networks for all subjects.

SMK Syubbanul Wathon Tegalrejo is an Islamic boarding school located in Magelang Regency, it has three study programs: Computer and Network Engineering, Multi Media, and Fashion Clothing program. Based on the teaching experience and the result of discussion with mathematics teacher at SMK Syubbanul Wathon Tegalrejo, the reseacher find out that some students are not able to relate concepts in mathematic, relate between mathematical concepts to other subjects, and to daily life problems. In addition, discussions with the mathematics teachers also find out some teachers still used conventional method in teaching. They assume that conventional learning can teach all material punctually.

The facts that exist encourage researchers to examine more deeply about the mathematical connection based on the thinking characteristics of XII

graders of SMK Syubbanul Wathon Tegalrejo towards discovery learning on a scientific approach. In this study, the researcher will describe the learning process, test the effectiveness of discovery learning with a scientific approach to examine more deeply about the mathematical connection based on the thinking characteristics. In this study, researcher will describe the learning process that takes place, test the effectiveness of discovery learning with a scientific approach to the student's mathematical connection ability, and describe the ability of mathematical connections based on the characteristics of the way of thinking owned by students' mathematical connection ability, and describe the mathematical connections ability based on the characteristics of the students' way of thinking.

METHOD

This research used mixed method concurrent embedded design which was a combination research method that combines qualitative and quantitative research methods by mixing the two methods unproportionality (Sugiyono, 2013). In this study, qualitative research methods had greater proportion than quantitative research methods. In this study, the experiment 1 class was treated by using discovery learning, in the experiment 2 class, it was treated discovery learning scientific approach, and the control class was treated by conventional learning.

The research was conducted in SMK Syubbanul Wathon Tegalrejo in the academic year 2015/2016. The population of this study is the students of class XII. The sample was chosen by random sampling, XII-G3, XII-G4, and XII-G6 were selected as control class, experiment class 1 and experiment 2 class as quantitative data sources. meanwhile, for the source of qualitative data, it was obtained by taking two sk students, two sa students, two ak students, two aa students. the data were obtained by testing the characteristics of way of thinking, observation, interview, documentation, and test of students' mathematical connection ability. the data analysis used was observation analysis, proportion test, anova test, gain test, and analysis of interview result.

Stages of data processing include data processing (test results characteristics of thinking, observation, interviews, documentation, and students' mathematical connection ability test), analysis and discussion of the results of data processing research,

and drawing conclusions based on research results to answer formulation problems that have been established.

RESULT AND DISCUSSION

Result

The result of this research is the analysis of learning quality of discovery learning model with scientific approach on the derived material of class XII function in SMK Syubbanul Wathon and analysis of mathematical connection ability based on the characteristic of student's way of thinking. Good quality of learning seen from the validity of instructional devices made, the criteria both on the learning process, and the effectiveness of learning is done.

At the planning stages, it found that the validation of the teacher learning device is good. Validation of this learning is done by expert validators. The result of learning device validation and research instrument are as follows: average of syllabus validation score is 4,45; including very good category. The average lesson plan validation score is 4.23; including very good category. The average hand on activity validation score is 4.18; including good category. Average the score mathematical connection ability test validation is 4.25; including very good category. Average the score way of thinking validation is 4; including good category. The average validation score of interview guidelines is 4.23; including very good category.

At the learning process stage, good quality is indicated by good criteria on the learning done. Data of learning process of mathematical model of discovery learning of scientific approach is obtained from observation of learning process during learning activity.

The observation sheet consisted of 27 observed activity items, in which the observer is asked to assess the learning process with the scale of the assessment of 1-5. The observations are made directly or indirectly by one observer. The study begins by selecting two classes of class of XII-G4 as experiment class 1 and class XII-G6 as experiment class 2. Experiment class 1 is a class that implements normal discovery learning while experiment class 2 is a class that implements discovery learning with scientific approach. The experiment class 2 is prepared as a class that the learning process was observed. In every meeting, the

assessment of the learning process is conducted by using the observation sheet, so that the learning process criteria obtained at each meeting.

Furthermore, it can be seen the whole learning process by looking at the average results of the learning process during the research process took place. The data obtained from the observation sheet instrument of the learning process is the data of mathematics learning process with the learning activities that apply the discovery learning model with the scientific approach. The learning process is measured from 3 dimensions, namely, (1) organizational strategy, (2) delivery strategy and (3) management strategy. The data from the learning process is then analyzed at each meeting by looking at the percentage of learning process obtained so that it can be criticized. The data from the learning process is then analyzed at each meeting by looking at the percentage of learning process obtained so that it can be criticized. At the meeting I to IV, discovery learning process of scientific approach is in percentage of "Good" criterion. Meanwhile, if it is seen from the average percentage of the learning process as a whole, in all meetings, it is obtained the percentage of 79.5%, it is on the "Good" criteria.

Based on the result of students mathematical connection test, then it is performed the test of completeness, the average difference test, and gain test to know the effectiveness of discovery learning scientific approach on the students' mathematical connection ability. The classical completeness test is performed to find out the complete proportion of students. Based on the results of the calculation of the learning completeness in the class is treated by discovery learning scientific approach by using proportion test, it is obtained $Z_{count} = 1.9702 \geq z_{0,5-\alpha} = 1.64$ so that H_0 is rejected. Therefore, based on the results of research, it can be concluded that the students' mathematical connection ability on discovery learning with a scientific approach that has reached the completeness of at least 70 reached more than 75%. The average difference to find out the students' mathematical connection ability, which class is better, it is between the class that is using discovery learning scientific approach with the normal discovery learning model and conventional learning. From the ANAVA table in the sig column. It is obtained value of P (P-value) = 0,000. Thus at the real level = 0.05, we reject H_0 , so it can be concluded that

the students' mathematical connections ability in discovery learning scientific approach, normal learning discovery learning model, and conventional learning have different improvement. Furthermore, to know the difference of average between each class, it is conducted advanced test. The advanced test used is the Pos Hoc Turkey test.

Table 1. Pos hoc test of mathematical conection ability

(I) Kelas	(J) Kelas	Mean Difference (I-J)	Std. Error	Sig.
Kontrol	Eksperimen1	-7.528*	2.781	.022
	Eksperimen2	-13.137*	2.885	.000
Eksperim en1	Kontrol	7.528*	2.781	.022
	Eksperimen2	-5.609	2.805	.118
Eksperim en2	Kontrol	13.137*	2.885	.000
	Eksperimen1	5.609	2.805	.118

In the above table 1, it can be seen that the average control class is different from the average of experiment class 1 and experiment 2. The average experiment class 1 is different from the control class, and the average of the experiment class 2 is different from the control class.

Data of characteristic test result of student's way of thinking is as follows: from 31 students, 7 students have characteristics of concrete sequential thinking; 5 students have characteristics of abstract sequential thinking; 14 students have characteristics of concrete random thought, and 5 students have characteristic abstract random thinking. Based on the result of the characteristic test of student's way of thinking, from the students one experimental class 2 was drawn by 8 students, each two students representing the characteristic group of concrete sequential thinking (CS), abstract sequence (AS), concrete random (CR), and abstract random (AR) as the subject chosen to be examined more deeply and interviewed about the ability of mathematical connections. The subsequent subjects were called CSS 1, CSS 2, ASS 1, ASS 2, CRS 1, CRS 2, ARS 1 and ARS 2. Interviewing activities focused on digging deeper information about how students solve mathematical connection problems based on the characteristics of the way they think.

The description of the ability of mathematical connections based on the characteristics of students are as follows: Based on the test mathematical connection

of students, CSS 1 is able to write down what is known and asked from the existing problems well. CSS 1 has not been exact in solving the problems concerning the equation of tangent curves. This is because CSS 1 has difficulty in relating between the concept of differential function, tangent gradient, and tangent curve equation. CSS 1 has been able to link the concept of differential functions, increasing function, and decreasing function, the concept of linear inequality. CSS 1 has been able to link the concept of differential function, stationary point, and linear equation in solving the problem. After the interview, CSS 1 proves difficult to relate the existing concepts. CSS 1 is also able to mention examples of other problems that use mathematical concepts and applied to other subjects and everyday life. From the results of interview students feel challenged to solve other lesson problems because it has already known the mathematical concepts that can be used in solving the problem. CSS 1 is also able to mention examples of other problems that use mathematical concepts and apply them in daily life.

Based on the answers of students' mathematical connection test, CSS 2 has been able to write down what is known and asked from the existing problems well. CSS 2 are able to relate the concept of function derivative, tangent gradient, linear equation, and equation of tangent curve so as to solve the problem well. CSS 2 have been able to link the concept of function derivation, up and down functions, and linear inequalities so as to solve the problem well. CSS 2 students are able to relate the concept of function derivatives, stationary values and linear equations in solving the problem. After the interview, CSS 2 did not find difficulties in linking the concepts that exist to complete the overall test questions given. CSS 2 is also able to mention examples of other problems that use mathematical concepts and applied to other subjects and everyday life. From the results of interview students feel challenged to solve other lesson problems because it already knows the mathematical concepts that can be used in solving the problem.

Based on the answers of students' mathematical connection test, ASS 1 has been able to write down what is known and asked from the existing problems well. In mentioning the concept of what is used, ASS 1 is able to mention the whole. ASS 1 is able to link the concept of function derivative, tangent gradient, linear equation, and equation of tangent curve so as to solve the problem well. ASS 1 has been able to link the

concept of function derivative, up and down function, and linear inequality so as to solve the problem well. ASS 1 is able to link the concept of function derivatives, stationary values and linear equations in solving the problem. In addition to solving the existing problems, ASS 1 is able to link existing concepts so that the solution is given exactly. After the interview, ASS 1 found no difficulty in using mathematical concepts to complete the whole test question. ASS 1 is also able to mention examples of other problems that use mathematical concepts and applied to other subjects but have not been able to mention examples of concepts related to everyday life. From the results of interview students feel challenged to solve other lesson problems because it already knows the mathematical concepts that can be used in solving the problem.

ASS has been able to write down what is known and asked from the existing problems well. In mentioning what concepts are used, ASS 2 is able to name it as a whole. ASS 2 is able to relate the concept of function derivative, tangent gradient, linear equations, and tangent curve equations so as to solve the problem well. ASS 2 has been able to link the concept of function derivatives, up and down functions, and linear inequalities so as to solve the problem well. ASS 2 is able to associate the concept of function derivatives, stationary values and linear equations in solving the problem. After the interview, ASS 2 did not find it difficult to use mathematical concepts to complete the whole test question. ASS 2 has not been able to mention examples of other problems that use mathematical concepts and applied to other subjects. but able to mention examples of other problems that use mathematical concepts and applied in everyday life.

From the answers to the students' mathematical connection test, CRS 1 has been able to write down what is known and asked from the problem. CRS 1 is able to use the concept of function derivative, the equation of tangent curve, tangent gradient, and tangent equation so as to obtain a perfect answer. CRS 1 has not been able to relate between gradients derived from the derivative of the curve function with a gradient parallel to the tangent curve. After the interview, CRS 1 was still finding difficulties in using mathematical concepts to solve the whole test question. CRS 1 was able to use the concept of a function derivative (up and down function) to answer the question. CRS 1 is able to cite examples of other

problems that use mathematical concepts and apply to other subjects and everyday life.

From the answers to the students' mathematical connection test, CRS 2 has been able to write down what is known and asked from the existing problems well. CRS 2 has been able to link the concept of the function derivative, the tangent gradient, and the equation of the tangent curve so as to answer the problem well. CRS 2 has been able to link the concept of function derivatives, up and down functions, and linear inequalities in solving existing problems. CRS 2 is able to relate the concept of function derivative, stationary value, and linear equations of one variable. After the interview, CRS 2 did not find it difficult to use mathematical concepts to complete the whole test question. CRS 2 is able to cite examples of other problems that use mathematical concepts and apply to other subjects. From the interview result the students do not find it difficult to give examples of problems related subjects that can be solved with the mathematical concept. CRS 2 uses the concept of stationary value to answer when the drug will react maximum. Although the concept used is correct, but the answer given is less precise. CRS 2 has been able to mention examples of other problems that use mathematical concepts and applied in everyday life.

From the answers of students' mathematical connection test, ARS 1 has been able to write down what is known and asked from the problems that exist well. Based on the answer of the number 1, ARS 1 is able to mention the concept used is the derivative of the function, the equation of the tangent curve, and the gradient of the curve and link it but not so accurate that the answer given is not correct. ARS 1 is able to mention the concepts used are the concept of function derivative, the equation of the tangent curve, the tangent curve gradient and the alignment of two straight lines but have not been able to link the concepts well. ARS 1 is able to associate the concept of function derivative, up and down function, and linear inequality of one variable in solving the problem. ARS 1 is able to associate the concept of function derivative, stationary value, and linear equations of one variable in solving the problems of numbers 5 and 6. After the interview, ARS 1 found no difficulty in using mathematical concepts to complete the whole test question. ARS 1 is able to mention examples of other problems that use mathematical concepts and applied to other subjects and everyday life

From the answers to the students' mathematical connection test, ARS 2 has been able to write down what is known and asked from the existing problems well. ARS 2 is able to mention the concepts used are the concept of function derivative, the equation of the tangent curve, the tangent curve gradient as well as linking the concepts well. ARS 2 is able to associate the concept of function derivative, up and down function, and linear inequality of one variable in solving the problem. ARS 2 is able to relate the concept of function derivative, stationary value, and linear equations of one variable in solving questions. After the interview, ARS 2 did not find it difficult to use mathematical concepts to solve the whole test question. ARS 2 is able to associate the concept of up and down functionality in solving problems related to when the ball will rise and when it will go down. ARS 2 has not been able to mention examples of other problems that use mathematical concepts and applied to other subjects. and in everyday life. From the results of interviews students find it difficult to solve the problem related problems in daily life and have not been able to provide other examples.

Discussion

Quality of learning is a series of activities that can improve student competence. The quality of learning is measured from the planning, process, and learning outcomes. At the planning stage, the researcher develops learning tools in the form of syllabus, lesson plan, hand on activity, and mathematical connection ability test. Devices that have been created are then validated by an expert validator. From the results of the validator assessment, obtained the average value for each device is good.

In the implementation stage of the learning process, the quality of the process is measure by observing the implementation of learning. The Observations were made 4 times. The observation learning done by researchers to assess the professionalism of researchers in implementing learning. The results of qualitative analysis indicate that the learning process of mathematics of discovery learning model with scientific approach on the derivative function of class XII is good.

At the outcome stage, the quality of learning is seen from the effectiveness of the learning. The result of quantitative analysis shows that discovery learning

of scientific approach on class XII is effective on students' mathematical connection ability.

In line with Indiastuti (2016) research result indicates that learning tool of science-based Discovery Learning model can facilitate students in developing the character of students' curiosity and creative thinking skill in class IX classroom constructions. This research has produced a valid learning tool, practical and effective.

The result of Rudyanto's research (2014) also stated that the learning of mathematical matter of waking up space by using learning device of discovery learning model with scientific approach is valid, practice, and effective on students' creative thinking ability.

CONCLUSION

Based on the analysis of research results and discussions that have been described in the previous chapter, the researcher conclude as follows: (1) The quality of learning discovery learning model with a scientific approach of class XII SMK on students' mathematical connection ability is good. The analysis results at the planning stage has good quality seen from the validation of learning devices that are in either category. At the learning process stage have good quality seen from observation during learning process of discovery learning model with scientific approach included in good criterion. At the stage of the research results, the researcher conclude that the implementation of discovery learning model with a scientific approach to the mathematical connection ability of students indicated by the indicator that is the ability of mathematical connections of students with discovery learning scientific approach is effective. (2) The results of this study also showed that students with different way of thinking have different mathematical connection ability.

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