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ANALYSIS OF STUDENT'S ABILITY IN MATH CONCEPTS AS A TOOL FOR STUDYING ECONOMIC THEORY

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Abstract

Mathematics in economics has an important role as a tool for quantitative analysis. By using mathematics, the expressions of theoretical economics in the form of verbal are modelled using symbols and equations. So far, the use of mathematics has been widely used in modelling and analysis of microeconomic theory, macroeconomic theory, econometrics, and so on. Seeing the importance role of mathematics in economics teaching and learning process in Department of Economics Development Studies, ideally, students must have smart in logic and a good analysis in basic mathematical concepts that will be used as the foundation of thinking in the study of economic theories. But, the fact remains that the majority of students is still weak in logic and basic mathematical concepts. Lack of student's logic and mathematical analysis capabilities today is caused by bad analysis in math concept while studying in senior high school. Many senior high school students who wanted to submit in department of economics development studies still considered that high logic and good analysis in basic mathematics concept is not required as well as the student who wanted to submit in the faculty of exact sciences.

This paper analyzes logical skill and mathematical concepts capabilities of the third-year student who is majoring in Department of Economics Development Studies, Faculty of Economics, Jenderal Soedirman University. Data were analyzed from 132 questionnaires were distributed to students of fifth, seventh, and nineth semesters as a respondent. The data analyzed include quantitative and qualitative data. Quantitative data comprises of the student's grade of math courses include: Mathematics of Economics I, Mathematics of Economics II, Statistics of Economics I, Statistics of Economics II, Econometrics, and Project Evaluation. Meanwhile, the qualitative data consisted of assessment of students about the difficulties in mastering math concepts in mathematical economics courses.

Based on the quantitative and qualitative data analysis using questionnaires analysis, it can be seen that most of the students are still difficult to use logic and mathematical concepts for modelling economic theory. The most difficult mathematical concepts understood by the students include: integral equation, descriptive statistics, differential equation, two and three variable equation, linear equation, matrices and inferential statistics.

There is a link between the ability of mathematical concepts while studying in high school students with math concepts ability students today. Besides the lack of guidance in the form of tutorials is still the biggest obstacle for students to understand and use math concepts in the study of economic theories.

Keywords: mathematics for economics, mathematical learning process in economics, questionnaires analysis.

INTRODUCTION

Mathematics in economics has a very vital role. The role of mathematics in the field of economics of which is used as a tool for quantitative analysis. In the early development economics, economic theory was introduced to the model in the form of verbal expressions qualitatively.

The development of economic science as multidimensional science is not quite the verbal qualitative approach. History records that the approach to economic analysis initially using verbal qualitative approach. Verbal qualitative approach is also known for its philosophical approach. This philosophical approach was first introduced by economist Adam Smith era. A qualitative approach in economic arguments described using verbal structures and do not provide the estimated numbers (Nachrowi, 2007). Today, economics is known as a multi-dimensional science that uses intuition qualitatively and quantitatively in explaining economic phenomena in community (Purbayu, 2010).

As a result of the impact of the increasing complexity of economic science that touches multidimensional analysis, teaching and learning process in economics science were introduced by using mathematical symbols and graphics. Most experts considered that neoclassic scholar was the pioneer of this approach. Neoclassical economic scholar began to spearhead quantitative approach using calculus and algebra-based math as tools for the analysis of economic theories (Nachrowi, 2007).

Using mathematical expressions, the form verbal of economic theories is modelled using symbols, symbols and equations. So far, the use of mathematics has been widely used in modelling and analysis of microeconomic theory, macroeconomic theory, econometrics, and so on. Quantitative approaches in economics widely used as tools in mathematical economics and econometrics. By using mathematics, economists use the theorems of calculus and algebra to make and model of new economic theories. Meanwhile, econometrics uses mathematical equations to model and empirical testing of economic laws (Nachrowi, 2007).

Neoclassical economic approach widely adopted by many countries in the world, including in the teaching and learning process system in Faculty of Economic and Business at various universities throughout the world. The hallmark of neoclassical approach is so dominant use of quantitative methods in economic analysis (Purbayu, 2010). The strength of mathematic with the power structure and reasoning is very powerful as excellent tools for analysis of economic problems in society. According Collander (2001) as stated by Purbayu (2010), 98 percent of students in Faculty of Economics and Business stated that mathematic is very important in the study of economics. There are many economic problem in society is solved successfully by using mathematic approach.

Quantitative approaches that used in economics use paradigm of positivism. Positivistic paradigm states that the validity of the science experimentally measured and justified based on empirical observation (Purbayu, 2010). A quantitative approach uses the analogy of developing exact sciences such as physics, chemistry, and engineering sciences. Analytical tools which used to develop of those sciences are calculus, analytic geometry, and statistics as part of the science of mathematics. The using of mathematic to analyze problem in those sciences was proved accurately in solving cases that happens in the universe.

According Nachrowi (2007), quantitative analysis in economics can be categorized into two: mathematical economics and econometrics. Mathematics used in economics to create and develop a theory deductively (Story, 2011). Meanwhile an econometric is a study of empirical observations that use statistical estimation and testing hypotheses. Econometrics, in other words, emphasis on empirical testing of economic theory, and is required for the inductive conclusions. Econometric experts generally use modified mathematical equations for empirical testing of economic laws.

Department of Economics Development Studies, Jenderal Soedirman University Purwokerto as a higher education institution educates students to be able to understand and analyze economic problems in daily life in the community. Developing of quantitative approach in learning process which is modelling the economic problems using mathematical tools are very important for students. Various issues relating to the economy of everyday life very well taught to students using as a model using mathematical analysis.

Analysis of demand and supply factor uses the linear equation as a model analysis. Meanwhile, the optimization of price is described well using simple differential equations and partial differential equations. Analysis Indonesian currency movements very accurately predicted using time series analysis and Fourier transforms. Even for modelling complex cases such as the prediction of property assets of land and building fuzzy logic-based mathematical approach was developed by researchers (Windhani and Hardoyono, 2011).

According to the facts, the mastery of mathematics as the tools for analysing economic problems in both the micro and macro scale are very important. Seeing the importance of the role of mathematics in economics teaching, ideally, students who are taking courses in economics of development studies have high logic skills and a good analysis of the basic mathematical concepts that will be used as the foundation of thinking in the study of economic theories.

Generally, learning model of cluster quantitative subjects such as mathematics and statistics is taught in Faculty of Economics and Bossiness science is relatively similar to the other courses. The selection of learning models adapted to the characteristics of the material, the circumstances of students and educational infrastructure that exists in the classroom.

Learning model in the cluster of quantitative subjects uses constructivist learning theory (Bigg, 1996; Soemarsono, 2009). Learning theory argues that learning is a process

of knowledge building which is done by the students based on the experience. The role of lecturers in learning process based on the theory of constructivism is reduced to create an atmosphere of student-cantered learning (SCL) model.

But the fact remains that the majority of students is not very good in mathematical concept as tools to analyze economic theories. Based on preliminary studies conducted, student mastery of basic math concepts as tools in the analysis of economic theories still requires a significant increase). The missing concepts can be seen by using indicators such as: the grade of the homework assignment, midterms test and final exams. Almost indicators show that student's ability in mathematics is not satisfied. More than 60% of students find difficulties in solving the cases of economic problems using mathematical concepts as tools for analysis. Some of the mathematical concepts that are still considered difficult problem for the students include linear equations, differential equations, integral, matrix, and inferential statistics. Through this study, we want to know the level of student's ability to understand mathematical concepts as an analytical tool in the study of economic theories.

GOAL OF STUDY

1. Analyze the student's ability in mathematical concepts in Department of Economic and Development Studies, Jenderal Soedirman University as a tool in studying the theory of economic.
2. Knowing the factors that affect the ability of student mastery of mathematical concepts as tools in the study of economic theory.

METHODS

Participants

A total of 131 students attending six different classes in were included in the study. They were all 21-23years old; there were 67 female students and 64 male students. They all attended at Department of Economic and Development studies, Jenderal Soediman University who are taking semester 5, 7, and 9.

Collecting of data

Measurement of student's ability in mathematical concepts uses questionnaire instruments. Each respondent was asked to complete a questionnaire that will be used an instrument to analyze the concept of math ability students. Indicators are used as analytical instruments consist of: background of student's ability in mathematical concepts at the high school level, student learning outcomes at cluster of quantitative subject, index of student's perceptions of learning process in cluster of quantitative subjects, and style of lecturer's lecturing process in cluster quantitative subject. The subjects examined include: mathematics of economics I, mathematics of economics II,

statistics of Economics 1, statistics of economics II, econometrics, and evaluation of projects.

Analyzing of data

Analysis of student's ability in mathematical concepts uses questionnaire analysis. Scale used to score every point possible answers in the questionnaire refers to the Likert scale. Score for conditions that are qualitatively used positive perception score is 1 for low to 5 for high for perception. In contrast to the data that is negative qualitative given a score of 1 to a high perception to 5 for low perception. Indicator of student's ability in mathematical concepts, the operational definition of each variable, assessment indicator and scoring technique are shown in Table 1.

Table 1 Indicators of student's ability, the operational definition of each variable, assessment indicators and scoring techniques

Indicators of student's ability	the operational definition	assessment indicators	scoring techniques
background brushes mathematics student at the high school level	Student math skills while studying in graduate school linked to the school status	Student's high school status	1 : private high school 2 : state high school
		Model of student's high school	1 : Pesantren 2 : Economic vocational school (SMEA) 3 : Engineering vocational school 4 : Islamic High School (MA) 5 : Regular high school (SMA)
		Prior student mastery in mathematic	1 : poor 2 : low 3 : moderate 4 : good 5 : excellent
		Student self perception about mathematic while studying in high school	1 : Very hate 2 : dislike 3 : similar like other subjects 4 : interesting 5 : very interesting and good performance
Student capability in mathematical concept	student learning outcomes at the course of cluster of quantitative subject	student learning outcomes at the course: mathematical economics I, mathematical economics II, economic Statistics 1, economic statistics II, econometrics, and evaluation of projects	1 : Fail (E) 2 : Poor 3 : moderate 4 : good 5 : excellent

		student remedial attempts at the course: mathematical economics I, mathematical economics II, economic Statistics 1, economic statistics II, econometrics, and evaluation of projects	1 2 3 4 5	: : : : :	4 times or more 3 time twice once never
	index of student's perceptions of learning process in cluster of quantitative subjects	Student's perceptions of mathematical contents (linear eq. Differential eq. 2/3 variables eq. Matrices, integral eq. Descriptive statistic, and inferential statistic)	1 2 3 4 5	: : : : :	Very difficult difficult moderate easy very easy

Table 1 continue...

Indicators of student's ability	the operational definition	assessment indicators	scoring techniques		
Main factor in mastering of mathematical concepts	Factors that affect the ability of students in the cluster of quantitative subjects	Style of student in studying quantitative subjects	1 2	: :	individual group discussion
		Student self confident in mathematic concept individually	1 2 3 4 5	: : : : :	Fail (E) Poor moderate good excellent
		Style in study	1 2 3 4 5	: : : : :	ignore depend on other student individual try error group discussion using software for mathematical tools
		Student knowledge in mathematical software (Excell, SPSS, minitab, matlab, and mapple)	1 2 3 4 5	: : : : :	Fail (E) Poor moderate good excellent
		Lecturer style in lecturing in cluster of quantitative subject	1 2 3 4 5	: : : : :	text book conventional semi analytic analytic student cantered learning
		Lecturer's attempts to give tutorial in cluster of quantitative subject	1 2 3 4	: : : :	never rare sometimes often

5 : always

In order to analyze student's ability in mathematical concept qualitatively in cluster quantitative subject based on table 1, we calculated the mean score and standard of deviation according to the equation:

$$\bar{z} = \frac{\sum z_i}{N} \quad (1)$$

$$S = \sqrt{\frac{\sum (z_i - \bar{z})}{N-1}} \quad (2)$$

Remarks:
$\bar{z}$: The mean score of each indicator
z_i : The value score of each indicator
S : Standard of deviation
N : Number of variables

Furthermore, to determine the student's ability in mathematical concepts, we used scoring techniques as follows Sugiono (2009):

$A_c \geq \bar{Z} + 2S'$: Student's ability in math concepts is excellent
$A_c \geq \bar{Z} + S'$: Student's ability in math concepts is good

$\bar{Z} \ll A_c \leq \bar{Z} + S'$: Student's ability in math concepts is moderate
$\bar{Z} - S' \leq A_c < \bar{Z}$: Student's ability in math concepts is bad
$A_c < \bar{Z} - S'$: Student's ability in math concepts is vey bad

Remarks:
A_c: Assessment of Student's ability in math concepts
$\bar{Z}$: The mean score of each indicator
S' : The standard of deviation of each indicator

RESULT AND DISCUSSION

The aims of this study are to analyze the ability of mathematical concepts of student in department of economic and development studies, Jenderal Soedirman University as a tool in studying the theory of economic and knowing the factors that affect the ability of student mastery of mathematical concepts as tools in the study of economic theory. We analyse row material of student based on prior education while studied in Senior High School. Majority of students (74.80% student) came from state senior high school. Only 25.20% students come from private senior high school. Based on model of school, the majority of student (83.96%) come from regular high school (SMA), 2,3% students come from pesantren and vocational high school (SMEA and STM), and the other (10.90% of student) come from Islamic senior high school (Madrasah Aliyah).

Furthermore, we analyzed prior student's ability mathematical concepts while is still studying in senior high school level. We analyze student's ability mathematical concepts based on average student's grade point that was reported by school every

semester and also student's grade point in National Examination. From questionnaire we get description of student's ability in mathematical concept and present in Table 2.

Table 2. Student's ability in mathematical concept based on average student's grade point that were reported by school every semester and also student's grade point in National Examination.

Indicator	Result
Max score	10.00
Min score	2.00
Mean score	7,99
Standard of deviation	1,54

Based on Table 2, we analyze student's prior ability in mathematical concept by using mean score and standard of deviation. The result of student's prior ability in mathematical concept presents in Table 3

Table 3 Descriptions of student's ability in mathematical concept based on average student's grade point that was reported by school every semester and also student's grade point in National Examination.

Grade	Criteria	Number of students	Percentage
Excellent	$\boldsymbol{A_c \geq \bar{X} + S'}$	19	14.50%
Good	$\boldsymbol{\bar{X} \leq A_c \leq \bar{X} + S'}$	75	57.25%
Moderate	$\boldsymbol{\bar{X} - S' \leq A_c \leq \bar{X}}$	12	9.16%
Bad	$\boldsymbol{\bar{X} - 2S' \leq A_c \leq \bar{X} - S'}$	20	15.27%
Poor	$\boldsymbol{A_c \leq \bar{X} - 2S'}$	5	3.82%

According to the Table 3, it can be concluded that the ability of students math concepts based on the background of mathematical skills when students learn in high school is good. More than 70% of the students admitted that their ability in mathematical concepts based on average student's grade point that was reported by school every semester and also student's grade point in National Examination is high. Only 28.25% students that their ability in mathematical concepts based on average student's grade point that was reported by school every semester and also student's grade point in National Examination is low.

In the questionnaire, we also asked about the student's perceptions about mathematics subject when students studied in senior high school. The analysis results are displayed in Table 4

Table 4. Description of perceptions about mathematics subject when students studied in senior high school

Grade	Criteria	Number of students	Percentage
Students considered that mathematics was the most difficult subjects	$\boldsymbol{A_c \geq \bar{X} + 2S'}$	0	0
Students considered that mathematics was as difficult as other subjects	$\boldsymbol{A_c \geq \bar{X} + S'}$	37	28.24

Neutral	$\bar{X} - S' \leq A_c \leq \bar{X} + S'$	71	54.20
Students considered that mathematics was as easy as other subjects	$\bar{X} - S' \leq A_c \leq \bar{X}$	21	16.03
Mathematics is the most favourite subject than other subjects.	$A_c \leq \bar{X} - 2S'$	2	15.27

According to Table 4, 28.24% of students considered that mathematics is difficult subject and more than 31.30% considered that mathematics is easy subject. More than half student was neutral in their perception.

Student's learning outcomes in subject of quantitative cluster.

To analyze student's learning outcomes in subject of quantitative cluster, we used student's final examination grade point from 6 subjects, and those are: mathematics of economics I, mathematics of economics II, statistics of economics I, statistics of economics II, econometrics, and project evaluation. The student's learning outcomes in subject of quantitative cluster are displayed in Table 5.

Table 5. Description of student's learning outcomes in subject of quantitative cluster

Subject	Student's grade point (in percentage)				
	E	D	C	B	A
Mathematics of economics I	3.05%	19.85%	54.96%	22.14%	0.00%
Mathematics of economics II	0.76%	19.08%	53.44%	26.72%	0.00%
Statistics of economics I	3.05%	20.61%	51.91%	24.43%	0.00%
Statistics of economics II	2.29%	22.14%	55.73%	19.85%	0.00%
Econometrics	1.53%	26.72%	58.78%	12.98%	0.00%
Project evaluation	0.76%	22.14%	64.12%	12.98%	0.00%
Microeconomics theory	0.00%	22.14%	49.62%	28.24%	0.00%
Macroeconomics theory	0.76%	19.85%	51.15%	28.24%	0.00%
Average	2.29%	15.27%	61.83%	18.32%	2.29%

By using data in table 4, it can be seen that student's average ability in mathematical concept by using grade point from six subjects from quantitative cluster is moderate. Only 21% of student got satisfied grade point (A and B). It was still more 19% of student got bad grade point (D and E). The most difficult subject in cluster quantitative is econometrics with more than 28% of student got bad grade point.

In the questionnaire, we also asked student's perceptions of the level of difficulty of some of the basic concepts of mathematics which is very useful to be an analytical tool in the study of economic theories. Description of the level of difficulty of mathematical concepts as perceived by students is shown in table 6.

Table 6. Description of the level of difficulty of mathematical concepts as perceived by students

Course materials	Student's perception about difficulty level (in percentage)				
	Very difficult	Difficult	Moderate	Easy	Very Easy
Linear equation	1.53%	12.98%	54.96%	29.01%	1.53%
Two and three variable equation	2.29%	12.98%	64.89%	19.85%	0.00%
Matrices	3.05%	9.16%	53.44%	32.06%	2.29%
Differential equation	1.53%	15.27%	78.63%	0.00%	4.58%
Integral equation	2.29%	24.43%	51.91%	19.08%	2.29%
Descriptive statistics	0.76%	20.61%	70.23%	8.40%	0.00%
Inferential statistics	0.00%	10.69%	72.52%	15.27%	1.53%

Based on the Table 6 we can make the course material difficulty level as perceived by students. Ordering the level of difficulty based on the level of difficulty of the material according to student's perception. Ordering the level of difficulty based on student's perception is displayed in Table 7

Table 7. Ordering the level of difficulty based on student's perception

Course materials	Student's perception about difficulty level (in percentage)	
	Level of difficultly	Index of difficulty
Integral equation	7	0.27
Descriptive statistics	6	0.21
Differential equation	5	0.17
Two and three variable equation	4	0.15
Linear equation	3	0.15
Matrices	2	0.12
Inferential statistics	1	0.11

Student's perceptions index of learning process in cluster of quantitative subjects.

In the index of perception will be discussed factors that affect student's ability to understand mathematical concepts as an analytical tool for studying economic theory. Several factors affect the ability of students to master mathematical concepts is student's learning model. Lecturer's teaching model and the use of media software used to assist students in mastering basic math concepts.

Based on the analysis of the questionnaire items, the main factors causing of low ability students in understanding the basic concepts of mathematics and statistics were factors of lecturer and student themselves. Two-thirds of the students claimed that the lack of mastery of mathematics and statistics concept due to the difficulty in understanding the explanation of material and lack of exercise independently. While a third of students admit that the main factor causing low ability students in understanding the concepts of mathematics and statistics caused by lecturer who are less able to explain the material well.

According to the perceptions of students, the majority of teachers have not been able to provide course materials in quantitative cluster satisfactorily. Only 12% of

students stated that the ability of lecturers to explain the concept of mathematics and statistics to be satisfactory to the students. Most students (88%) stated that teachers have not been able to deliver course material in accordance with the expectations of students. Some models the desired learning by students include the provision of tutorial as enrichment materials and the use of software in teaching by lecturers who are used as a tool to explain the matter in more detail, and easily understood by students.

CONCLUSION

Based on the quantitative and qualitative data analysis using questionnaires analysis, it can be seen that most of the students are still difficult to use logic and mathematical concepts for modelling economic theory. Student's average ability in mathematical concept by using grade point from six subjects from quantitative cluster is moderate. Only 21% of student got satisfied grade point (A and B). It was still more 19% of student got bad grade point (D and E). The most difficult subject in cluster quantitative is Econometric with more than 28% of student which got bad grade point.

Based on index difficulty, we can order the difficulty the material subjects. Those are: integral equation (0.27), descriptive statistics (0.21), differential equation (0.17), two and three variable equation (0.15), linear equation (0.15), matrices (0.12) and inferential statistics (0.11).

There is a link between the ability of mathematical concepts while studying in high school students with math concepts ability students today. According to the perceptions of students, the majority of teachers have not been able to provide course materials in quantitative cluster satisfactorily. Only 12% of students stated that the ability of lecturers to explain the concept of mathematics and statistics to be satisfactory to the students. Most students (88%) stated that lecturers have not been able to deliver course material in accordance with the expectations of students. Besides the lack of guidance in the form of tutorials is still the biggest obstacle for students to understand and use math concepts in the study of economic theories.

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