

## Application And Perspective Of Open Ended Approach To Student Learning Outcomes In Business Math Subject

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### ABSTRACT

This research was conducted with the aim to apply open ended approach in business mathematics course in order to increase learning outcomes, but also to see the perspective of students after the open ended approach implemented. The population of this research is STIE Ekuitas students who are taking business math course, while the sample is selected by purposive sampling as many as 81 people (2 classes). The results of the assessed study consisted of 3 (three) components of the ability of conceptual skills, procedural, and problem-solving skills. Preparations and posttest are given in the form of a description consisting of 10 (ten) questions, while to see the perspective of students used 9 (nine) items. Testing is done using t-test and MANOVA. The conclusions of this research are (1) there are significant differences in ability between students who are given mathematics learning using open ended and conventional students, especially conceptual, procedural, and problem solving skills; (2) the use of open ended can strengthen the knowledge of students in thinking of mathematics, as an effort to solve problems, and (3) open ended enables students to interact with their friends through discussion, so that students can gain knowledge about mathematics more broadly.

**Keywords:** open ended, business mathematics, learning outcomes

### INTRODUCTION

The rapid growth of information technology in the last decade has led to new and more complex problems. The solving of such problems necessarily demands a simple process of thinking. In order for a person to be able to find answers and make rational decisions from complex problems, it is necessary an analysis, synthesis, and perhaps also an evaluation which certainly requires decision makers with critical and systematic considerations. The world of education as a means of improving one's ability certainly has an obligation to prepare his students to be trained in critical thinking through learning and materials delivered. The teaching should be conceptualized and followed by the method of teaching Polya (1) to understand the problem / see, (2) to plan / plan, (3) implement the plan / do, and (4) make an assessment of the solution obtained / check.

One of the lessons according to Polya's method is mathematics, because in mathematics all concepts are structured hierarchically, structurally, logically, and systematically so as to improve students' ability to solve problems, whether in education or in everyday life. That is why mathematics is so important in human life that it is taught from elementary school to college.

Polya teaching methods can improve one's ability in critical thinking, where the critical way of thinking that will not appear just to every individual. Need an effort from various parties (one of them are lecturers) to familiarize students are able to think critically. Students must be familiarized to be able to understand, comprehend, analyze and ultimately can take a conclusion/decision of a problem. This is important for students to be able to answer the

increasingly tough challenges in this globalization era. This ability can be developed in each course one of them in Business Mathematics course.

Mathematical learning can make a person able to think critically, because mathematics can (1) train thinking and reasoning in drawing conclusions, (2) develop creative activities involving imagination, intuition and discovery by developing divergent, original thinking, curiosity, prediction and (3) developing problem-solving skills, and (4) developing the ability to convey information and communicate ideas (Depdiknas 2004 in Herman (2007)). Assessment of tasks on the open ended approach allows for variation of answers, so it can be a discussion for the students (Riverstone and Fung, 2007). Through the open-ended approach the students are given the opportunity to expand their abilities especially conceptual skills and deepen students' understanding of the lessons (Capraro and Zientek in Al-Absi, 2013).

Munroe (2015) created a framework of an open ended approach consisting of 2 (two) main sections of understanding and applying mathematical knowledge. Both sections are analyzed and cross checked with the responses from the students to produce a conclusion that teachers can use the framework in open ended learning. A study in Thailand resulted in the discovery that an open ended approach proved to be integrated with lesson study to produce an innovative mathematics teaching and to improve the quality of education (Inprasitha, 2006). The integration of the open ended approach has also been done by Sullivan, et al (2000) by listing 1200 responses from students about the mixing of open ended and close ended, and the results show that open ended and close ended can be done together to make learning more effective.

To achieve all these objectives requires a learning approach that not only apply the conventional method (face-to-face), but it takes a more real learning approach. One of them is through approach open ended. According to Inprasitha in Irawan and Surya (2017) open ended is a media approach in problem solving used to evaluate the ability of high-level thinking in learning mathematics. This approach involves students in solving problems through the formulation of appropriate solutions, while Muhsinin (2013) finds that approach open ended is an approach in mathematics learning that can give students the flexibility to think actively and creatively. This is because in an open-ended approach it applies a lesson that presents an open problem, ie a mathematical problem that has a method or method of completion of more than one and more than one correct answer. Thus, students have the freedom in their own way to solve the problem. Herman's (2007) study concluded that students who received an approach open ended demonstrated a significantly better mathematical disposition than students who received structured learning, while research conducted by Al-Absi (2013) concluded that the open ended tasks approach had a positive effect on achievement learning mathematics students. Attali and Powers (2010) stated that giving feedback on the answers given by students in an open ended approach can give students the opportunity to revise their answers. This can improve students' ability and view of mathematics.

Based on the above explanation it can be drawn an opinion that the open ended approach is basically similar to problem-based learning (problem solving), which distinguishes between them is in problem-based learning students are trained to solve problems with one correct answer while in open ended student learning trained to solve problems with more than one correct answer. Each student will have different answers according to the student's ability to understand and analyze the problem. Therefore, in open ended learning is not the final result assessed, but the process through which the final results are assessed by the lecturer. Bush and Greer in Al-Absi (2013) explain that the appraisal process for the level of understanding and the thinking process are classified into four categories namely,

1. Closed tasks such as multiple choice, true/false, simplify, and others.
2. Open tasks such as giving a question with one correct answer with several alternatives, giving the questions with some correct answers and ways to retrieve the answer/solution.
3. Presentation.
4. Informally as class discussions.

Taking into account the above description, the researcher is interested to do an open ended approach in Business Mathematics course with Depreciation material. The selection of the Depreciation material is due to the fact that in calculating a depreciation asset, the student is taught with 4 (four) methods that each method will produce a somewhat different end result. Through open ended in this depreciation material, students are trained to be able to apply one method according to the existing problems, so that students can be trained in taking a decision by critical thinking. Four methods can be used in making a depreciation calculation, (1) the straight-line method, (2) the year number method, (3) the double-declining balance method, and (4) the unit of production method. In solving one depreciation problem, students are given the freedom to make decisions using which method they think is appropriate to the type of assets and type of company and available data.

The observation part of the open ended approach application is one of the conceptual capabilities of the respondents. A person's conceptual ability is very important for every teacher because the conceptual ability of a person will greatly affect his thinking process. According to NCTM in Azis (2013) conceptual understanding ability can be seen from one's ability to,

1. Define in verbal and written concepts
2. Identify and create examples and not examples
3. Using models, diagrams and symbols to present a concept
4. Convert a form of representation to another form
5. Know the various meanings and interpretations of concepts
6. Identify the properties of a concept and recognize the conditions that define a concept
7. Compare and differentiate concepts.

Good conceptual ability will influence a person in making a decision, in which the decision will be taken with a number of considerations in accordance with the concept understood. If it happens to a person, then it can be said that the person has been able to apply the procedure, where the main characteristic of procedural capability is the ability of a person to prepare the steps to be taken in solving a problem appropriately. Skemp (1997) defines the application of procedures as an instrumental understanding and the rules used without necessity. So the application of the procedure is to apply a settlement step if the requirements of the problem faced are known. According to Hiebert in Owen and Super (1999) the application of the procedure is divided into two parts: (1) the application of symbols without including what the symbol means, and (2) knowledge of a set of rules or steps that constitute an algorithm or procedure.

### RESEARCH METHODS

The research was carried out in STIE Ekuitas Bandung in 2017. The selection of research object was done by purposive sampling which is from 365 students who take the subject of Economic Mathematics, taken as many as 82 students (2 classes). This study has 2 (two) objectives: (1) analyzing the application of open ended approach to conceptual, procedural, and problem solving abilities and (2) looking at the perspective of the open ended approach to the students.

Obtaining data to answer the first objective of the research is done by giving the pretest and postes which will be compared by using paired t test (parametric difference test on two paired data), normality data test is done by using Shapiro Wilk and Kolmogorov Smirnov. During the course of conducting the research, the open ended approach of the students is trained to solve the problem by (1) understanding the problem / identification, (2) making the plan to get the solution, (3) executing the plan in accordance with the available data / information, and (4) after the solution is obtained by the student are required to re-check the truth of the solution. The test instrument is in the form of a description item that has been tested for its validity, reliability, and power of dissemination by using different objects. Pretest and posttest questions consist of 10 (ten) descriptions in which each question will assess students in terms of conceptual, procedural, and problem-solving abilities. The conceptual capability consists of 2 (two) questions, the procedural ability consists of 3 (three) questions, and the problem solving ability consists of 5 (five questions).

While the data for the second purpose of the research was obtained by giving questionnaires about the opinions and experiences of students during the learning of open ended approach. Answers to the questionnaire obtained will be calculated frequency and percentage so that the student perspective can be seen on the open ended approach. The questionnaire given to the student contains 9 (eight) statements with 2 (two) answer choices namely "Yes" and "No". Here are the statements given to students,

1. The open ended approach helps to locate my lack of math.
2. The open ended approach allows me to solve the problem by being structured through accurate data.
3. The open ended approach to mathematics can solve daily problems.
4. The open ended approach makes me happy to discuss with friends.
5. The open ended approach allows me to openly accept disagreements with friends.
6. An open ended approach makes learning math easier.
7. An open ended approach can solve problems with multiple paths.
8. The open ended approach makes me happy to learn math.
9. The open ended approach allows me to make the decision with a clear mind.

### **RESULTS AND DISCUSSION**

The normality test of learning result data was done by Shapiro Wilk and Kolmogorov-Smirnov test at significance level ( $\alpha$ ) 0,05. In this case tested is the null hypothesis which states that the sample comes from a normally distributed population. Acceptance or rejection is based on: a) if the value of sig. or significance or probability less than 0.05 then the data distribution is not normal, and b) if the value of sig. or probability more than 0.05 then the normal data distribution. From the results of the calculation of normality test obtained the following calculation results,

**Table 1. Data Normality Test of Conceptual, Procedural, and Problem solving**

	Stra_Pembel ajaran	Tests of Normality					
		Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Conceptual	<i>Open ended</i>	.084	49	.200*	.988	49	.888
	convensional	.119	47	.091	.969	47	.239
Procedural	<i>Open ended</i>	.105	49	.200*	.970	49	.240
	convensional	.116	47	.130	.927	47	.006
Problem solving	<i>Open ended</i>	.105	49	.200*	.970	49	.240
	convensional	.116	47	.130	.927	47	.006

\*. This is a lower bound of the true significance.  
a. Lilliefors Significance Correction

Table 1 shows that test results from Shapiro-Wilk and Kolmogorov-Smirnov for conceptual, procedural, and problem solving abilities found that the significance numbers were greater than 0.05, the conceptual, procedural and problem-solving data distribution was normal. The average pre-test is shown in table 2 below,

**Table 2. Pre-test based on procedural capabilities**

Group of Learning Strategy	N	Score		Range	Mean	SD
		Min	Max			
Open ended	41	10	25,50	15,50	9,95	3,439
Convensional	41	8,50	25,50	17,00	12,32	4,183

**Table 3. Pre-test based on conceptual capabilities**

Group of Learning Strategy	N	Score		Range	Mean	SD
		Min	Max			
Open ended	41	5,05	25,50	20,05	13,95	4,439
Convensional	41	9,50	30,50	21,00	15,32	3,485

**Table 4. Pre-test of problem solving**

Group of Learning Strategy	N	Score		Range	Mean	SD
		Min	Max			
Open ended	41	7,50	20,50	13,00	14,95	2,537
Convensional	41	8,50	17,50	9,00	12,32	3,243

Tables 2, 3 and 4 above explain that the average pretest results of procedural, conceptual, and problem-solving comprehensions between open ended and conventional classes are relatively similar.

The average post-test of students after using open ended is as follows,

**Table 5. Post-test based on procedural capabilities**

Group of Learning Strategy	N	Score		Range	Mean	SD
		Min	Max			
Open ended	41	20,00	40,50	20,50	30,95	3,876
Convensional	41	15,50	30,50	15,00	23,32	3,183

**Table 6. Post-test based on conceptual capabilities**

Group of Learning Strategy	N	Score		Range	Mean	SD
		Min	Max			
Open ended	41	10	45,00	35,00	30,95	2,765
Convensional	41	15,00	45,00	30,00	25,32	4,183

**Table 7. post-test of problem solving**

Group of Learning Strategy	N	Score		Range	Mean	SD
		Min	Max			
Open ended	41	15	60,50	45,50	56,95	3,439
Conventional	41	8,50	25,50	17,00	17,32	4,183

From table 5, 6, and 7 above it can be described, that the post-test averages result are relatively the same for procedural, conceptual abilities. As for the ability to solve the average problem between open ended class and conventional class has a very long range that is equal to 39.63.

### Pre-test Data Analysis

Analysis of pretest data aims to determine whether there are differences in learning outcomes in the form of procedural, conceptual, and problem solving skills. The analysis was performed by using different test (t-test). Different test results (t-test) Mean scores of procedural, conceptual, and problem-solving skills learned with open ended and conventional learning strategies can be seen in table 8 below,

**Table 8. Differential Tests of Average procedural ability**

		<i>Procedural Ability</i>	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F	2.711	
	Sig.	.103	
t-test for Equality of Means	t	-.110	-.109
	df	94	87.819
	Sig. (2-tailed)	.913	.913
	Mean Difference	-.08446	-.08446
	Std. Error Difference	.76993	.77358
	95% Confidence Interval of the Difference	Lower	-1.61317
	Upper	1.44426	1.45291

The t-test results from the two analytical groups as shown in the above table obtained t-test for Equality of Means with sig. (2-tailed)  $0.913 > 0.05$  ( $H_0$  accepted  $H_1$  rejected), mean the mean pretest of procedural abilities in the open ended and conventional classes did not differ significantly. The result of the t-test of the average score of conceptual ability can be seen in table 9 below,

**Table 9. Differential Tests of Mean Conceptual Ability**

		<i>Conceptual Ability</i>	
		Equal variances assumed	Equal variances not assumed
Levene's Test for Equality of Variances	F	2.383	
	Sig.	.126	
t-test for Equality of Means	t	1.744	1.677
	df	94	68.740
	Sig. (2-tailed)	.084	.098
	Mean Difference	1.35073	1.35073
	Std. Error Difference	.77466	.80561
	95% Confidence Interval of the Difference	Lower	-1.18737
	Upper	2.88882	2.95799

The t-test results from the two analytical groups as shown in the above table obtained t-test for Equality of Means with sig. (2-tailed)  $0.084 > 0.05$  ( $H_0$  accepted), means the average pretest of second-class conceptual ability does not differ significantly.

**Table 10. Differential Test Average of Problem Solving Ability**

		<i>Problem Solving Ability</i>		
		Equal variances assumed	Equal variances not assumed	
Levene's Test for Equality of Variances	F	2.711		
	Sig.	.103		
t-test for Equality of Means	t	-.110	-.109	
	df	94	87.819	
	Sig. (2-tailed)	.813	.813	
	Mean Difference	-.08446	-.08446	
	Std. Error Difference	.76993	.77358	
	95% Confidence Interval of the Difference	Lower	-1.61317	-1.62182
		Upper	1.44426	1.45291

The t-test results from the two analytical groups as shown in the above table obtained t-test for Equality of Means with sig. (2-tailed)  $0.813 > 0.05$  ( $H_0$  accepted  $H_1$  rejected), mean the average pretest of problem solving skills in the open ended and conventional classes did not differ significantly.

Based on the results of the calculations in table 8, 9, and 10 it can be concluded that there is no significant difference in average score either in the form of procedural, conceptual, and solving problems between groups of students who dibelajarkan with open ended learning strategies and groups of students who dibelajarkan conventional learning strategies before being given different treatment.

### Hypothesis Testing

Hypothesis testing aims to examine the hypotheses that have been formulated in this research through post-test analysis of procedural, conceptual, and problem solving. Skills are as dependent variables and open ended learning strategies as independent variables. Test assumptions or test requirements that include: (1) test data normality and (2) homogeneity test of variant between groups performed before analyzing with MANOVA. The test is done by using SPSS version 17 software for windows. The result obtained shows that the data is normal, and both research groups have homogeneous variant characteristics. The homogeneity test of the variants between groups is aimed to examine the similarity of open ended group variables and the conventional group. In total the results of the analysis for each dependent variable can be seen in table 11 below,

**Table 11. Homogeneity Test of Dependent Variables Based on Learning Strategy**

		Test of Homogeneity of Variance			
		Levene Statistic	df1	df2	Sig.
Procedural Ability	Based on Mean	2.711	1	81	.103
	Based on trimmed mean	2.728	1	81	.102
Conceptual Ability	Based on Mean	1.728	1	91	.192
	Based on trimmed mean	1.725	1	91	.192
Problem Solving Ability	Based on Mean	0.711	1	91	.203
	Based on trimmed mean	0.728	1	91	.202

Based on homogeneity test results of each group and variables are presented in table 11 shows the significance (sig.) > 0.05. Therefore, it can be said that between homogeneous groups for both dependent variables.

### Hypothesis Testing with MANOVA

Hypothesis testing research done by analyzing data of learning result which divided into three part that is procedural, conceptual, and solving ability. This test is done to prove the truth of hypothesis that is proposed. Testing is done by using multivariate analysis of Variances (MANOVA) at significance level 0.05 with the help of Statistical Package for Social Science (SPSS) software version 17.0 for Windows obtained the results presented in tables 12 and 13 below,

**Table 12. Multivariate Analysis Results**

Effect	Multivariate Tests <sup>a</sup>					
	Value	F	Hypothesis df	Error df	Sig.	
Intercept	Pillai's Trace	.993	6759.079 <sup>b</sup>	2.000	91.000	.000
	Wilks' Lambda	.007	6759.079 <sup>b</sup>	2.000	91.000	.000
	Hotelling's Trace	148.551	6759.079 <sup>b</sup>	2.000	91.000	.000
	Roy's Largest Root	148.551	6759.079 <sup>b</sup>	2.000	91.000	.000
Strategy	Pillai's Trace	.013	.590 <sup>b</sup>	2.000	91.000	.037
	Wilks' Lambda	.987	.590 <sup>b</sup>	2.000	91.000	.037
	Hotelling's Trace	.013	.590 <sup>b</sup>	2.000	91.000	.037
	Roy's Largest Root	.013	.590 <sup>b</sup>	2.000	91.000	.037
	Wilks' Lambda	.804	11.062 <sup>b</sup>	2.000	91.000	.000
	Hotelling's Trace	.243	11.062 <sup>b</sup>	2.000	91.000	.000
	Roy's Largest Root	.243	11.062 <sup>b</sup>	2.000	91.000	.000
	Wilks' Lambda	.970	1.391 <sup>b</sup>	2.000	91.000	.024
	Hotelling's Trace	.031	1.391 <sup>b</sup>	2.000	91.000	.024
	Roy's Largest Root	.031	1.391 <sup>b</sup>	2.000	91.000	.024

a. Design: Intercept + Strategi  
 b. Exact statistic  
 c. Computed using alpha = .05

### Grouping Based on Open Ended and Conventional Learning Strategies

The null hypothesis ( $H_0$ ) and work hypothesis ( $H_1$ ) of this research are as follows,

**$H_0$ :** There is no significant difference in procedural, conceptual, and problem-solving skills between students taught by open ended and conventional learning strategies.

**$H_1$ :** There is a significant difference in procedural, conceptual, and problem-solving skills between students who are taught by open ended and conventional learning strategies.

The results of the multivariate test analysis showed the test results with Pillai's Trace procedure, Wilks' Lambda, Hotelling's Trace, Roy's Largest Root, all of them showed significance (sig) = 0.037 < 0.05. This means that  $H_1$  is accepted, meaning that it can be concluded that there is a significant difference in procedural, conceptual, and problem-solving abilities between students studying with an approach open ended conventionally.



**Table 13. Tests of Between-Subjects Effects**

Tests of Between-Subjects Effects						
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Procedural Ability	172.990 <sup>a</sup>	3	57.663	3.698	.015
	Conceptual Ability					
	Problem Solving Ability	114.308 <sup>b</sup>	3	38.103	7.338	.000
Intercept	Procedural Ability	137704.657	1	137704.657	8832.046	.000
	Conceptual Ability					
	Problem Solving Ability	49024.289	1	49024.289	9441.776	.000
Strategy	Procedural Ability	16.754	1	16.754	1.075	<b>.003</b>
	Conceptual Ability	2.351	1	2.351	.453	<b>.003</b>
	Problem Solving Ability	9.543	1	9.543	1.838	<b>.037</b>
Error	Procedural Ability	1434.416	92	15.591		
	Conceptual Ability					
	Problem Solving Ability	477.689	92	5.192		
Total	Procedural Ability	143672.500	96			
	Conceptual Ability					
	Problem Solving Ability	50985.750	96			
Corrected Total	Procedural Ability	1607.406	95			
	Conceptual Ability					
	Problem Solving Ability	591.997	95			

a. R Squared = .108 (Adjusted R Squared = .079)  
b. R Squared = .193 (Adjusted R Squared = .167)  
c. Computed using alpha = .05

Table 13 shows the results of variables of learning approaches to the dependent variable of procedural, conceptual, and problem-solving abilities with  $\text{sig} = 0.003 < 0.05$  (for procedural and conceptual capabilities),  $\text{sig} = 0.037 < 0.05$  (for problem solving). These results reinforce that there is a significant difference between the students who are taught by the end-to-end approach with students who are taught by the conventional approach. Table 14 below shows the student perspective on the use of open ended in mathematics,

**Table 14. Student perspective on the use of open ended in mathematics**

No	Statement	Frequency		% say "Yes"
		Yes	No	
1	The open ended approach helps to locate my lack of math	56	25	69,14
2	The open ended approach allows me to solve the problem by being structured through accurate data	76	5	93,83
3	An open ended approach to mathematics can solve everyday problems	80	1	<b>98,77</b>
4	The open ended approach makes me happy to discuss with friends	65	16	80,25
5	The open ended approach allows me to openly accept disagreements with friends	67	14	82,72
6	The open ended approach makes learning math easier	56	25	69,14
7	The open ended approach can solve the problem in many ways	77	4	95,06
8	The open ended approach made me enjoy learning math	78	3	<b>96,30</b>
9	The open ended approach enables me to make a decision with a clear mind	66	15	81,48

Based on the student's response, the following results are obtained that,

1. Students realize that math can solve everyday problems. It is seen from the high percentage of students who answered statement number 3 that is 98.77%.
2. Open ended approach also makes students become happy to learn math (statement number 8 with percentage 96,30). In general, the percentage rate that answers "yes" is above 50, it shows that the open ended approach can influence students to think mathematically, the open ended approach increases students' self confidence to discuss, accept differences of opinion, give the students opportunity to explore their mathematical ability solve the problem.

### CONCLUSION

There are significant differences in ability between students who are given learning mathematics by using open ended and conventional, especially procedural, conceptual, and problem-solving abilities.

The use of open ended can strengthen the knowledge of students in mathematical thinking, in an effort to solve the problem. Students' efforts to solve problems with all their mathematical skills can make students aware of the importance of student learning. Students realize that solving a problem requires a capability that can not be obtained simply but must be learned.

Open ended allows students to interact with their friends through discussion, so that students can gain knowledge about math more widely. This has a positive impact because students become accustomed to accept differences of opinion.

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