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Application Ability of Students in Integrated Computer-Aided Numerical Analysis Learning

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ABSTRACT

The low ability of students to apply in numerical analysis courses is a problem in this research. Integrated learning is one solution to this problem. The aim is to determine the differences in student application abilities between integrated and conventional learning. One of the computer science colleges in the Cirebon area was sampled in this study. Two groups were formed, consisting of 1 integrated study group with a total of 36 students and one conventional study group with a total of 32 students. Both groups contracted numerical analysis courses. The type of quasi-experimental research was carried out, and the static group comparison randomized control group only design became the design in this study. The result is that the average value of the application ability of students who study conventionally is 80.31, while the average application ability of students who study in an integrated manner is 84.58. The application ability of students who study integrated is higher than students who study conventionally, and the ability to apply of students who study integrated is more uniform than students who study conventionally. The results of the Mann-Whitney test found that the application ability of students who studied in an integrated manner was better than those who studied conventionally.

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1. INTRODUCTION

The ability of students to apply mathematics in connecting mathematics with computer science is still low, which makes this research carried out [1]–[6]. This is caused by students who do not know much about the relationship between mathematics and the computer science they are studying. Weak basic mathematical abilities are a barrier for students in understanding computer science [7]–[10]; not a few students think there is no

link between mathematics and computer science, and students lack the application of mathematics in the computer science they are studying. Therefore, this study aims to determine the difference in the application ability of numerical analysis students using computer-assisted integrated learning compared to students who study conventionally.

In Bloom's taxonomy, applicability is a cognitive ability that expects students to demonstrate their understanding of mathematical abstractions through proper use when asked to do so [11]–[13]. To demonstrate this ability, a student must be able to choose and use what they have appropriately according to the situation in front of him [14]–[17]. The development of mathematical concepts, in this case, numerical analysis, should not be limited to the topics discussed but should also be linked to relevant topics, even with other fields of study, if possible, in an integrated manner.

Integrated learning is learning that focuses on learning approaches between topics and even between disciplines. The concept of integrated learning allows students to be learners, and the process involves the development of student thinking [18]–[25]. This is supported by one of the mathematical principles according to NCTM [26] that mathematics is a relationship. This means that the mathematical concepts of numerical analysis relate to the computer science concepts students are studying. The benefits of this integrated learning include: (a) more awareness of the importance and strategic importance of mathematics for other fields of science, (b) a better understanding of the role of mathematics in life, and (c) better ability to think logically, critically, and systematically, and (d)) more creative and innovative in finding solutions to solve a problem.

The use of computers in the world of education is used for learning has expanded and reached various interests, significantly improving the quality of learning. Computer-assisted integrated learning, such as visual basic, Borland, Microsoft excel, and Mathematica, is used in learning that links numerical analysis material with the use of computers as one of the skills of informatics engineering students. Computer-assisted learning, or what is known as Computer Assisted Instruction (CAI), is learning that uses computers as a learning tool to improve the quality of learning [27]. The quality of learning can be seen and observed by analyzing student abilities. The student's ability is the ability to apply. This ability is one of the measures analyzed in this study.

2. METHOD

This research is quasi-experimental. According to Ruseffendi [28], experimental research is generally conducted to compare two or more groups and use specific statistical

measures. In this quasi-experimental study, the subjects were not randomly grouped but selected based on naturally formed groups.

The research design used was the static group comparison randomized control group only design [29]. This design was chosen because the researcher assumed that the subjects were not grouped randomly, but the researcher accepted the subject's condition as simple as that. In this study, there are also different treatments and posttests. In the following, the research design of the static group comparison randomized control group only design is presented.

Experiment Class	X	O
Control Class		O

Information:

O : Postest

X : Numerical Analysis Integrated Learning

- - - : Subjects are not grouped randomly

The population in this proposed research is all College of Computer Science students, while the sample taken is makeshift, namely students of the Cirebon Polytechnic College of Computer Science who contracted a numerical analysis course. The sample of this study used two classes consisting of an experimental class that studied integrated learning. The number of students who participated in the experimental class was 36, while the number of students who participated in the control class was 32. The teaching materials were used as student assignment sheets and carried out for seven meetings. Students are given assignment sheets to solve equations in the computer-assisted numerical analysis as a skill possessed by informatics engineering students.

3. RESULTS AND DISCUSSION

Following the design of the research conducted, the results obtained in the form of the average value of the application ability of students who study conventionally is 80.31, while the average application ability of students who study in an integrated manner is 84.58. This shows that the average application ability of students who study in an integrated manner is higher than that of students who study conventionally. In addition, the value of the application ability of students who study in an integrated manner is 3.46, and the value of the application ability of students who study conventionally is 4.91. This

means that the ability to apply students who study in an integrated manner is more uniform than those who study conventionally.

Table 1. Data of Mean Value, Standard Deviation, and Normality

		EKSPERIMEN	KONTROL
N		36	32
Normal Parameters[a,b]	Mean	84,5833	80,31250
	Std. Deviation	3,45894	4,908436
Most Extreme Differences	Absolute	,326	,268
	Positive	,285	,173
	Negative	-,326	-,268
Test Statistic		,326	,268
Asymp. Sig. (2-tailed)		,000[c]	,000[c]

Table 2. Variance Homogeneity Test Data

		Levene Statistic	df1	df2	Sig.
Kemampuan Penerapan	Based on Mean	8,217	1	66	,006
	Based on Median	8,927	1	66	,004
	Based on Median and with adjusted df	8,927	1	65,919	,004
	Based on trimmed mean	9,089	1	66	,004

Table 1 and Table 2 provide information that the sample from the population is not normally distributed, and the data used has a non-homogeneous variance. This is because the significance value calculated by computing 0.000 and 0.006 is smaller than the specified error level of 5%. To determine whether the application ability of students who study in an integrated manner is better than students who study conventionally, the Mann-Whitney test is carried out because the sample used is not normally distributed and has a non-homogeneous variance. The results of the Mann-Whitney test can be seen in Table 1.3 below.

Table 3. Mann Whitney Test Data

	Kemampuan Penerapan
Mann-Whitney U	306,000
Wilcoxon W	834,000
Z	-3,624
Asymp. Sig. (2-tailed)	,000

Table 3 provides information that the application ability of students who study in an integrated manner is better than students who study conventionally. This can be seen from the computer's half-significance value of 0.000, which is smaller than the specified

half-level error value of 0.025. This means that the null hypothesis cannot be accepted significantly. So, students who study numerical analysis using computer-assisted integrated learning have better application skills than students who study conventionally. This is because students who study in an integrated manner are required to solve problems with student learning of programming in making computer programs to complete the numerical analysis. Two different knowledge disciplines, mathematics, and computers, are challenged to apply their knowledge to solve these mathematical problems, namely finding solutions to non-linear equations with their knowledge.

As the result of this integrated learning, students can add to what has been previously obtained by solving these mathematical problems, students can get something new in making programming language syntax to solve these mathematical problems, significantly solving non-linear equations, and students are more familiar with making computer programming with solve math problems. This is supported by Erman Suherman [30], [31] that integrated learning influences students, namely (a) more aware of the importance and strategies for other fields of science, (b) a better understanding of the role of mathematics in life, (c) better able to think logistics, critical, and systematic, and (d) more creative and innovative in finding solutions to problem-solving. The results of solving the non-linear equation problem combined with computer programming can be seen in the figure below.

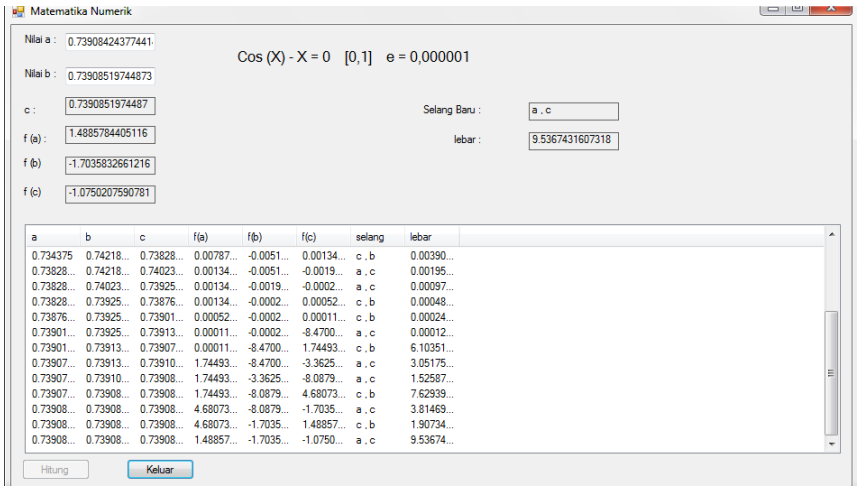

Figure 1. Integrated Learning Outcomes 1

In the picture above, the student solved the non-linear equation cos (x) –x = 0 with an initial value of [0,1], an error of 0.000001, and solved by the bisection method. The root of the equation found by students who studied integrated learning assisted by Visual Basic was 0.73908.

	A	B	C	D	E	F	G	H	I
1	Iterasi	a	b	m	f(a)	f(b)	f(m)	selang baru	f(m)<0.000001
2	0	0,000000	1,000000	**0,304718**	1,000000	**-2,281718**	**0,891976**	m,b	Lanjut
3	1	0,304718	1,000000	**0,500129**	0,891976	**-2,281718**	**0,398287**	m,b	Lanjut
4	2	0,500129	1,000000	**0,574417**	0,398287	**-2,281718**	**0,126319**	m,b	Lanjut
5	3	0,574417	1,000000	**0,596742**	0,126319	**-2,281718**	**0,035686**	m,b	Lanjut
6	4	0,596742	1,000000	**0,602952**	0,035686	**-2,281718**	**0,009750**	m,b	Lanjut
7	5	0,602952	1,000000	**0,604641**	0,009750	**-2,281718**	**0,002639**	m,b	Lanjut
8	6	0,604641	1,000000	**0,605098**	0,002639	**-2,281718**	**0,000713**	m,b	Lanjut
9	7	0,605098	1,000000	**0,605222**	0,000713	**-2,281718**	**0,000192**	m,b	Lanjut
10	8	0,605222	1,000000	**0,605255**	0,000192	**-2,281718**	**0,000052**	m,b	Lanjut
11	9	0,605255	1,000000	**0,605264**	0,000052	**-2,281718**	**0,000014**	m,b	Lanjut
12	10	0,605264	1,000000	**0,605266**	0,000014	**-2,281718**	**0,000004**	m,b	Lanjut
13	11	0,605266	1,000000	**0,605267**	0,000004	**-2,281718**	**0,000001**	m,b	Lanjut
14	12	0,605267	1,000000	**0,605267**	0,000001	**-2,281718**	**0,000000**	m,b	Stop

Figure 2. Integrated Learning Outcomes 2

In figure 2 above, the student solved the non-linear equation $e^x - 5x^2 = 0$ with an initial value of [0,1], an error of 0.000001, and solved by the false position method. The root of the equation found by students who studied integrated with the help of Microsoft Excel was 0.605267.

```
In[23]:= FindRoot[Exp[x] - 5 * x^2, {x, 0, 1}, MaxIterations → 20]
Out[23]= {x → 0.605267}

In[24]:= Subtract[0.6052671213146185`, 0.605263]

Out[24]= 4.12131 × 10^-6
```

Figure 3. Integrated Learning Outcomes 3

In figure 3 above, the student solved the non-linear equation$e^x - 5x^2 = 0$ with an initial value of [0,1], an error of 0.000001. The root of the equation found by students who study integrated with the help of Mathematica 6.0 is 0.605267. Some of the integrated learning outcomes above reflect that this learning aligns with students' abilities to explore their knowledge, especially those based on information technology.

4. CONCLUSION

This research has several conclusions: the average value of the application ability of students who study conventionally is 80.31, while the average application ability of students who study in an integrated manner is 84.58. The application ability of students who study integrated is higher than students who study conventionally, and the application ability of students who study integrated is more uniform than students who study conventionally. The results of the Mann-Whitney test found that the application ability of students who studied in an integrated manner was better than those who studied conventionally.

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