THE ROLE OF SCIENTIFIC CALCULATORS IN IMPROVING STATISTICS LEARNING

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Abstract
In its development, Business Statistics has used several types of technology to facilitate the learning process for students, such as statistical software, spreadsheets, calculators, multimedia materials, and data repositories. The calculator includes computer technology with a simple version but allows students to experience an active learning process. Thus, the calculator media was chosen as the main learning media in business statistics courses, including in evaluating student abilities. Therefore, this study aims to determine the effectiveness of using calculators in Business Statistics courses. The research was conducted using a mix method, namely qualitative (questionnaire) and quantitative (experimental). The results showed that there was an increase in the average value of Simple Linear Regression for groups of students who used statistical applications on calculators compared to groups who did not use calculators. Based on the results of the questionnaire and suggestions, it was found that 87.7% of students considered it easy to understand the Business Statistics application questions, when using the statistical application on a calculator. Suggestions made by students were the availability of guidelines for using statistical calculator applications for practice, and the availability of calculators in the research laboratory that students could use for practice.

Keywords: statistic, scientific calculator, laboratory

Abstrak
Dalam perkembangannya, Statistika bisnis telah menggunakan beberapa jenis teknologi untuk memudahkan proses pembelajaran bagi mahasiswa, seperti: software statistik, spreadsheet, kalkulator, materi multimedia, dan repositori data. Setiap karakteristik alat olah Statistika ini, memiliki kelebihan dan kekurangan, sehingga sampai saat ini belum ada satu alat yang mampu mencakup semua kemungkinan penggunaan teknologi untuk pendidikan [2, 3]. Dari ketiganya, kalkulator termasuk teknologi komputer dengan versi sederhana namun memungkinkan mahasiswa mengalami proses pembelajaran secara aktif. Kalkulator dinilai sebagai media yang mudah dibawa dan terjangkau [4]. Sehingga, media kalkulator dipilih sebagai media belajar utama dalam mata kuliah Statistika bisnis, termasuk dalam mengevaluasi kemampuan mahasiswa. Oleh karenanya, studi ini bertujuan untuk mengetahui efektivitas penggunaan kalkulator dalam mata kuliah Statistik Bisnis. Riset difokuskan dengan mix method yaitu kualitatif (kuesioner) dan kuantitatif (eksperimen). Hasil penelitian menunjukkan bahwa terdapat peningkatan nilai rata-rata Regresi Linear sederhana dari kelompok mahasiswa yang menggunakan aplikasi statistika dalam kalkulator dibandingkan kelompok yang tidak menggunakan kalkulator. Berdasarkan hasil kuesioner dan saran, diperoleh bahwa 87,7% mahasiswa menganggap mudah memahami soal aplikasi Statistika Bisnis, jika menggunakan aplikasi statistika dalam kalkulator. Saran yang disampaikan mahasiswa adalah keberadaan panduan penggunaan aplikasi statistika kalkulator untuk latihan, dan ketersediaan kalkulator di laboratorium Riset yang dapat digunakan mahasiswa untuk latihan.

Kata kunci: statistic, kalkulator ilmiah, laboratorium

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INTRODUCTION

Since the advent of mainframe computers, scientists and statisticians have used computers to perform complex calculations at much faster speeds. However, as technology developed, computers were transformed into smaller handheld devices called calculators. Therefore, calculators become accessible to students as a portable and affordable problem-solving tool. As well as being the only technological tool that is universally accessible, scientific calculator tools are also evolving to become more capable of illustrating representation (from data and statistics), computation (from various statistics), exploration (using data transformations and alternative bivariate models) and assertions (e.g., anticipating the relationship between the model and the prediction) (Tucker, Shaw, Son, & Stigler, 2023; Verhulst, 2017).

One type of scientific calculator that is currently quite popular in the world of statistics is the scientific calculator. A scientific calculator is a handheld, battery-powered device equipped with functions for plotting graphs, providing numerical solutions to equations and performing statistical calculations, operations on matrices and performing more advanced mathematical functions such as algebra, geometry and advanced statistics (Kor & Lim, 2003; Lee, Vaskalis, Stokes, & Harrison, 2022). The scientific calculator was first discovered in 1985, when it was developed by Casio, and then further developed by Texas Instruments in 1995. With the invention of the scientific calculator, the idea emerged to use it in solving statistical problems, which previously could only be done by computers (Parrot & Leong, 2018; Waits & Demana, 1998).

Additionally, the results of previous studies have proven that the use of scientific calculators can improve student competence, especially in learning Mathematics and Statistics. For example, the results of research (Boon, Yong, Han, & Gaik, 2009) show that using a scientific calculator has a positive effect on students' ability to get the correct solution and reduces the time to solve problems. Then, (Collins & Mittag, 2005; Drottar, 1998; Harskamp, Suhre, & Van Streun, 2000) found that competence in Statistics can be improved by using a scientific calculator. Therefore, teachers and students must interact in the language of mathematics through the use of appropriate calculators (Drottar, 1998; Jiang, Cayton-Hodges, Oláh, & Minchuk, 2023). Furthermore, (Harskamp et al., 2000; Tucker et al., 2023) concluded that teaching Statistics using a scientific calculator helps students achieve higher learning in advanced statistical concepts.

The significant important to use a calculator in teaching Statistics because traditional methods tend to take a long time and the results do not reach the target in achieving higher Statistics competencies (Wijaya et al., 2019). Statistics is an academic discipline that is closely related to mathematics, and provides university graduates with a basis for conducting research. Research Ellington (Dunham & Dick, 1994; Ellington, 2003; Tan, Harji, & Lau, 2011) shows that there is a significant increase in the
level of competence in descriptive statistics after the use of a scientific calculator. It is also known that students show higher competence in the concept of inferential statistics after applying learning to descriptive statistics. This study aims to find out how teaching Statistics using a scientific calculator helps students achieve higher learning in advanced Statistics concepts.

**METHOD**

The sample used was students of the Bandung State Polytechnic, Department of Business Administration, Marketing Management Study Program level one (1) who received business statistics lessons, both practice and theory with a load of 3 credits and a time range of 5 hours (3 hours of practice and 2 hours of theory). Sampling is based on convenience sampling, not randomly because the class has been determined. The number of samples is 60, with 30 samples of class A and 30 samples of class B. The dependent variable in this study is the average value of Simple Linear Regression and the independent variable is the control class group and the experimental class group.

The first instrument used was a business statistics ability test for Simple Linear Regression material from two class groups, the control class (without using the Statistical application on the calculator) and the experimental group (using the statistical application on the calculator). This component is used to measure the ability of Marketing Management students who are given treatment and who are not given treatment, the treatment in this case is the use of a science calculator tool. Furthermore, a questionnaire was also used to measure the cognitive and non-cognitive aspects of Marketing Management students by assessing using a Likert scale, and recording suggestions openly regarding learning outcomes, the questionnaire had to be estimated for its validity and reliability (HR & Aithal, 2022). The research hypothesis can be formulated as follows:

- **H0**: There is no difference in the average value of Simple Linear Regression from the group that uses the statistical application on the calculator and the group that does not use the application on the calculator.
- **Ha**: There is a difference in the average value of Simple Linear Regression from the group that uses the statistical application on the calculator and the group that does not use the statistical application on the calculator.

Furthermore, quantitative analysis is used to reveal the development of academic achievement of marketing students, in this case the achievement scores for the Business Statistics course through a quasi-experimental design and using the Independent T-Test approach. The Independent T-Test is a comparative test or different test to find out whether there is a significant mean difference between 2 independent groups with interval or ratio data scales (Okunev, 2022). The two independent groups referred to here are two unpaired groups, meaning that the data sources come from different subjects ("SPSS Tutorials: Independent Sample Test," 2023; Yu et al., 2022). Data must meet requirements,
including independent variable that is continuous (i.e., interval or ratio level), independent variable that is categorical, independent samples, random sample of data from population, normal distribution, homogeneity of variances, and no outliers (Sumilat, 2022).

There are actually two forms of the test Statistic for this test, depending on whether or not equal variances are assumed (Agustin & Akbarjono, 2022; Indrawati, Ninghardjanti, Dirgatama, & Wirawan, 2022). The description as follows:

**Equal Variances Assumed**

When the two independent samples are assumed to be drawn from populations with identical population variances, the test statistic \( t \) is computed as:

\[
\begin{align*}
\bar{x}_1 - \bar{x}_2 &= t \\
\frac{s_p}{\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} &= \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}
\end{align*}
\]

With

\[
s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}
\]

Where

- \( \bar{x}_1 \) = Mean of first sample
- \( \bar{x}_2 \) = Mean of second sample
- \( s_1 \) = Standard deviation of first sample
- \( s_2 \) = Standard deviation of second sample
- \( s_p \) = Pooled standard deviation
- \( n_1 \) = sample size of first sample
- \( n_2 \) = sample size of second sample

The calculated \( t \) value is then compared to the critical \( t \) value from the \( t \) distribution table with degree of freedom \( df = n_1 + n_2 - 2 \) and chosen confidence level. If the calculated \( t \) value is greater than the critical \( t \) value, then we reject the null hypothesis.

**Equal Variances Not Assumed**
When the two independent samples are assumed to be drawn from populations with unequal variances, the test statistic $t$ is computed as follows:

$$
t = \frac{\bar{x}_1 - \bar{x}_2}{s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}
$$

Where

$\bar{x}_1$ = Mean of first sample

$\bar{x}_2$ = Mean of second sample

$s_1$ = Standard deviation of first sample

$s_2$ = Standard deviation of second sample

$s_p$ = Pooled standard deviation

$n_1$ = sample size of first sample

$n_2$ = sample size of second sample

The calculated $t$ value is then compared to the critical $t$ value from the $t$ distribution table with degree of freedom:

$$
df = \frac{s_p^2 \left( \frac{1}{n_1} + \frac{1}{n_2} \right)^2}{\left( \frac{s_1^2}{n_1} \right)^2 + \left( \frac{s_2^2}{n_2} \right)^2 + \frac{1}{n_1 - 1} \left( \frac{s_1^2}{n_1} \right)^2 + \frac{1}{n_2 - 1} \left( \frac{s_2^2}{n_2} \right)^2}
$$

If the calculated $t$ value is greater than the critical $t$ value, then we reject the null hypothesis.

In this study, the average value of the simple linear regression group being compared was the average value of the control group (not using a statistical application on a calculator) and the average value of the experimental group (using a statistical application on a calculator). Then because the measurement scale on the questionnaire with closed statements/questions is the Likert scale, so the test analysis uses the $t$ test. Whereas for questionnaires with open statement types, it is sufficient to record them.

RESULTS AND DISCUSSION

The sample in this study were International Marketing Management Students Class A and B of 2023, respectively 28 and 29 people who received Business Statistics course material with a weight of 3 (three) credits and an allocation of 5 hours (3 hours of practice and 2 hours of theory) a week. The material or subject matter for Business Statistics chosen by the experiment using a calculator is Simple
Linear Regression. Technically, the samples were randomly grouped into two groups, the control group (the group that did not use the Statistics application on the calculator) and the experimental group (the group that used the Statistics application on the calculator), totaling 28 and 29 people respectively.

The research was conducted using a mixed method, namely qualitative and quantitative (experimental) on Marketing Management students. Qualitative information was obtained through developing a questionnaire based on the instruments which were summarized in statements using a Likert scale. The statements contain the characteristics of learning Business Statistics, the use of a calculator, and the use of a calculator as a tool in learning Business Statistics. The questionnaire was tested for validity and reliability, with the following results:

Table 1. Validity Test Result

<table>
<thead>
<tr>
<th>Statement</th>
<th>Corrected Item-Total Correlation</th>
<th>Cronbach’s Alpha if Item Deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>0.533</td>
<td>0.779</td>
</tr>
<tr>
<td>P2</td>
<td>0.578</td>
<td>0.771</td>
</tr>
<tr>
<td>P3</td>
<td>0.498</td>
<td>0.787</td>
</tr>
<tr>
<td>P4</td>
<td>0.609</td>
<td>0.771</td>
</tr>
<tr>
<td>P5</td>
<td>0.605</td>
<td>0.776</td>
</tr>
<tr>
<td>P6</td>
<td>0.565</td>
<td>0.773</td>
</tr>
<tr>
<td>P7</td>
<td>0.472</td>
<td>0.793</td>
</tr>
</tbody>
</table>

Table 1 shows that the questionnaires distributed met the validity test requirements, meaning that the statements submitted to the 57 respondents were in accordance with the variable measurement standards. This can be seen from the Corrected Item-Total Correlation values, each of which is greater than \( r_{table} = 0.4438 \), meaning that the questionnaire statements are valid. Furthermore, the reliability test for all question items obtained the following results:

Table 2. Reliability Test Result

<table>
<thead>
<tr>
<th>Cronbach’s Alpha</th>
<th>Cronbach’s Alpha Based on Standardized Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.804</td>
<td>0.804</td>
</tr>
</tbody>
</table>
Table 2 shows the value of Cronbach's Alpha Based on Standardized Items of 0.804 which is greater than 0.4438, meaning that the questionnaire statements are reliable. Next is the result of the analysis of the respondents' answers on the role of the calculator in improving the performance of learning statistics.

Table 3. Frequency Results

<table>
<thead>
<tr>
<th>Statement</th>
<th>Percentage of Respondents' Answers (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
</tr>
<tr>
<td>Business Statistics material can be understood if it is accompanied by examples of application questions</td>
<td>0</td>
</tr>
<tr>
<td>Completion of Business Statistics application questions can be understood easily, if done using a statistical application on a calculator</td>
<td>1,8</td>
</tr>
<tr>
<td>Solving Business Statistics application questions can be understood easily, if done using the statistical application in SPSS</td>
<td>1,8</td>
</tr>
<tr>
<td>The existence of a calculator as a tool for learning business statistics is needed to help understand Business Statistics material</td>
<td>1,8</td>
</tr>
<tr>
<td>The use of a calculator in learning course material that requires calculations will help speed up completion.</td>
<td>1,8</td>
</tr>
<tr>
<td>The calculator supports daily work, financial planning, and completing calculation operations</td>
<td>0</td>
</tr>
</tbody>
</table>
The use of a calculator in lecture material that requires calculations facilitates completion.

<table>
<thead>
<tr>
<th></th>
<th>1.8</th>
<th>0</th>
<th>10.5</th>
<th>28.1</th>
<th>59.6</th>
</tr>
</thead>
</table>

Table 3 explains that 93% of students want to study Business Statistics along with application in the study program, namely Marketing Management. Then, as many as 87.7% of students thought it was easy to understand the Business Statistics application questions, when using the Statistics application on a calculator. As for other tools that are considered to make it easier for students to understand Business Statistics is statistical software such as SPSS, it is proven that 75.4% of students agree with it. However, it also turns out that as many as 94.7% of students stated that calculators are needed in learning Business Statistics both as calculating tools and statistical applications as data processing.

Furthermore, apart from the Business Statistics course, students also receive other courses that require calculation processes, such as Business Mathematics, Accounting, and so on, so that as many as 94.6% of students say they need a calculator as a learning aid. Calculators, in everyday life are needed as a tool for calculating financial planning, calculating costs, and so on, students dominate where as many as 87.7% of students consider the problem of calculating lecture material calculations to be easy if assisted by a calculator.

Additionally, to further explore the benefits of using a calculator as a learning tool for Business Statistics, respondents were asked to provide their input in open statements (suggestions). As a result, students first assess the benefits of calculators, including helping in understanding the material, making calculations easier and being resolved more quickly. Then the use of a calculator is also considered to be more precise and accurate than calculating manually. However, it was also revealed that these benefits would be obtained if intensive training was often carried out, especially to find out the button functions that would facilitate the calculation process and also to practice frequently in using statistical applications in calculators. Furthermore, the second suggestion is related to procuring calculator media with uniform types and capacities, especially when learning Business Statistics so that it makes it easier for students to understand instructions for their use. Furthermore, and no less important, students suggest the availability of a manual for using a calculator containing how to use statistical applications accompanied by examples of applications and simple steps so that students can easily understand them. Finally, regarding practicum time in the laboratory, students suggest that there should be additional time so that students are more free to practice operating statistical applications in calculators so that they are more proficient.
Moreover, the assumptions that must be fulfilled for the difference test (T-test) are normality and homogeneity. For the normality test, the following is the output:

**Table 4. Normality Test Results**

<table>
<thead>
<tr>
<th></th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
</tr>
<tr>
<td>Controlled Group=1</td>
<td>0.946</td>
</tr>
<tr>
<td>Experiment Group=2</td>
<td>0.962</td>
</tr>
</tbody>
</table>

Table 4 shows that Shapiro Wilk's sig (probability) value for the variable. The Linear Regression values for both the control class and the experimental class were 0.167 and 0.394, respectively, greater than 0.05. This means that the linear regression value variable is normally distributed.

**Table 5. Descriptive Statistics**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled Group=1</td>
<td>27</td>
<td>47.04</td>
<td>8.636</td>
<td>1.662</td>
</tr>
<tr>
<td>Experiment Group=2</td>
<td>28</td>
<td>78.18</td>
<td>10.917</td>
<td>2.063</td>
</tr>
</tbody>
</table>

Table 5 shows the average value of the control class linear regression of 47.04 and the average linear regression value of the experimental class of 78.18, there is a very sharp increase in the average value. Likewise, the standard deviation value of the average linear regression value for the control class is 8.638 and the standard deviation value for the experimental class is 10.917, there is a fairly high increase in value.

**Table 6. Homogeneity Test and Independent Sample Test**

<table>
<thead>
<tr>
<th></th>
<th>Levene's Test for Equality of Variances</th>
<th>t-test for Equality of Means</th>
</tr>
</thead>
</table>

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Table 6 shows that the significance value (Sig) of Levene's Test for Equality of Variances is 0.089 which is greater than 0.05, meaning that the data is homogeneous. While the significance value (Sig. (2-tailed) of 0.000 is less than 0.05 (assuming the variance is the same). This indicates that the null hypothesis (H₀) is rejected, meaning that there is a difference in the achievement scores of Linear Regression Marketing Management students for the experimental class or class that uses statistical applications on calculators. The results of this study are in line with previous findings, where the use of scientific calculators can increase student competence, especially in learning Mathematics and Statistics. For example, the results of research (Boon et al., 2009) show that using a scientific calculator has a positive effect on students' ability to get correct solutions and reduce problem solving time. Then, scientific calculators are proven to be able to increase student competence in the field of statistics (Wei & Johnson, 2018; Wijaya et al., 2019). Therefore, teachers and students must interact in the language of mathematics and statistics through the use of appropriate calculators (Harskamp et al., 2000). Furthermore, (Parrot & Leong, 2018; Rich, 1990) concluded that teaching Statistics using a scientific calculator helps students achieve higher learning in advanced Statistics concepts.

CONCLUSIONS

Based on the aforementioned description and analysis, it can be concluded that the need for a calculator as a calculating tool and an auxiliary tool in Business Statistics courses, especially the application of statistics contained in calculators, cannot be avoided anymore. This is evidenced by the questionnaire, 87.7% of students consider the statistical application contained in the calculator, besides
speeding up the calculation process it also helps in understanding the application of Business Statistics questions. Furthermore, a manual for using a calculator is urgently needed by students to further improve their skills in using statistical applications in calculators. Finally, the availability of calculators that contain statistical applications, such as the FX 991 ES Plus type calculator in the Marketing Research laboratory is highly expected, so that students get convenience when practicing Business Statistics courses.

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