Influence of SAS Software on the Learning of Statistics at the University Level

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Abstract

This article examines the use of the SAS tool in the learning of statistics. the type of research was applied with a quasi-experimental design and quantitative approach, the sample was determined by a non-probabilistic method comprising 28 students for both groups; for the collection of information, a pre-test and a post-test were applied, validated with expert judgment and V. Aiken, its reliability with the Spearman Brown coefficient. After the experiment, the results showed higher averages in favor of the experimental group to whom the SAS software was applied in its statistical learning dimensions at a descriptive and inferential level. In order to know the distribution of the data, the Shapiro Wilk numerical method was used, the result of the test gave the certainty to choose the T-Student test for two independent samples at 95% with a level of confidence and 0.05 significance. It is concluded that the SAS software improves the levels of learning of statistics, increases their creativity, they feel more motivated, and there is an interaction favoring more active learning.

Keywords: Learning, Statistics, SAS Software, Technologies, Descriptive, Inferential.

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1 Introduction

Nowadays, thanks to the support of technology, teaching, and learning activities are enriched and learning is transformed. In this research, the SAS software facilitated access to information, statistical calculations, and procedures and allowed the results to be shown in an easy, motivated, interactive, and creative way. In addition, it allowed the information to be analyzed in order to conclude. It also encouraged, in the student, more active learning; however, there are still barriers to the lack of use and application of technologies by some teachers in statistics, especially the lack of knowledge of the use of different technological tools for other areas (González Aldana, M.A., 2017).

In this perspective, our research work revealed the impact of SAS software in the learning of statistics at the university level; in this sense, we described some background and theories that help to support it. In the context in which we find ourselves, there is no reason to justify and create learning environments using various software for statistics as they will allow students to manipulate real data in order to store, select, tabulate, calculate, graph, analyze and interpret information that responds to their needs and make good decisions (Burgos, R.A.G., 2013).

Along the same line, it conducted research on the statistical model of multiple regression using SAS software, the results showed optimal levels in an organization; therefore, SAS software is not only applicable in education but also in other areas (Garzón Celis, D.C., 2022). SAS was investigated as a research tool for learning; its aim was to provide feedback to students as they learn and record its effects on processing and learning outcomes. The findings showed capabilities and options, as well as the use of the technological environment, reading and learning for research, and getting a lot of information and procedures for solving tasks (López-Iñesta, E., 2018).

The assessment of project-oriented statistics learning in engineering students was investigated; the type of research was qualitative. The results showed that, in a higher percentage, they could correctly apply descriptive statistical procedures and use computer resources in the analysis of information in an autonomous and motivated way, using appropriate strategies; however, in a small group, the level was low for reading and interpreting figures, associating statistical measures and determining relationships between variables (Alvarado Martínez, H.A., 2018).

It was investigated that SAS software as well as SPSS and R between the years 2005 to 2020 are the most used packages in various disciplines, primarily in research, it is useful for analyzing statistical data; the study aimed to describe trends in the use of statistical software in research; SAS software was highlighted as well as SPSS; it is concluded that SAS allows aligning students in their various interdisciplinary research practices (Curtis, M.L., 2022).

In other research, learning styles in statistics and academic performance were significantly related to students at the university level (Huamán Gutiérrez, Z.J., 2021). Regarding the use of free statistical software for data analysis Jamovi, Jasp, and R, it was indicated that this software has a simple, intuitive, and user-friendly interface in their working environment and does not require licensing for use in most cases. Thanks to technological and computing progress, several licensed and unlicensed statistical programs are available, such as SPSS, MINITAB, STATGRAPHICS, GOOGLE SPREADSHEET, MS. EXCEL, PYTHON, and SAS (Sánchez-Villena, A., 2019).

Statistics and Computing in the development of scientific or technological research projects had a preponderant role when using S.A.S. software because its interface has descriptive procedures, and diverse graphic methods, and allows classifying variables, measures of association, and linear regression, in that sense the software is important in the field of research (Silva, C., 2017).

Along the same lines, it was emphasized that statistical education is a prodigy for researchers who have the ability to understand and interpret information; however, unfavorable attitudes can still be seen in university students, which are reflected in their unsatisfactory results; on the other hand, in the use of computer applications, shortcomings are observed, with little understanding of statistical concepts and probability models (Ramos Vargas, L.F., 2019).

Along the same lines, three key aspects were pointed out: the teaching of statistics, its didactics, and the attitude of students to the use of the software. Regarding the first aspect, statistics is not only a collection of concepts and techniques but, above all, a way of reasoning necessary in most fields, in any science or job (Cabero, J., 1991).

Since the emergence of the internet until today, they have enabled various practices, knowledge achievement in teaching and learning, and the application of various technological tools related to the consumption and transmission of information (Raffino, E., 2019).

The results were processed with IADOV methods and the elaboration of the Fuzzy Cognitive Map, showing that ICT has been integrated in a significant and impressive way in daily life; therefore, it has been necessary to increase and link their use to the teaching-learning process in the classroom. It is concluded that it has a positive impact on the learning of statistics (Tumaya, J.L.V., 2022).

The research was carried out on the resources and strategies for teaching statistics at the university level with the aim of raising awareness and reflecting on the teaching of the subject; the study analyzed the factors in the teaching-learning process in the training of various disciplines, the pedagogy of teachers, teaching styles, classroom experiences, and the use of teaching resources. The results showed that digital media and social networks constitute a new challenge for the teaching of statistics (Medina-Hernández, E.J., 2022).

As for the dimensions of our dependent variable called learning statistics, it comprises descriptive statistics based on the collection, organization, presentation, analysis, and publication of the observed results, the aim of which is to describe the main characteristics of a sample, which can be done using tables, charts, graphs or figures ((Baiardi, F., 2016). The other dimension was inferential statistics, which is based on the calculation of probabilities and uses the results of descriptive statistics in order to generalize and apply the concepts to the population, concluding by contrasting hypotheses (Guerrero, J.A.M., 2020).

It was emphasized that statistical competencies and capabilities are manifested through the exploration of more precise results; with assertions and critical reasoning based on objective evidence and the great power of synthesis and abstraction. In that sense, our study seeks to enable students to develop their skills and competencies with more active learning (Toapanta-Toapanta, G.M., 2018).

In these times, organizations have developed various statistical software to adapt to each context or need; in this sense, our university teachers must know and use current technologies in order to contribute to improving the quality of education. On the other hand, our students must interact in an autonomous, collaborative way, promoting more active and motivated learning, given that the latter stimulates the student with the aim of solving problems and satisfying needs (Peiró, R., 2020)].

2 Objectives

This research work set out to analyze the influence of SAS software on the learning of Statistics at the university level and, as specific objectives, to determine the influence of SAS software on the learning of Statistics in its descriptive level dimension; to determine the influence of SAS software on the learning

of Statistics in its inferential level dimension and, as a final aim, to establish differences in the level of learning of Statistics in the control and experimental groups after the application of SAS.

3 Methodology

It aimed the application of SAS software as a methodological strategy at improving the learning process in the General Statistics course for students in the third cycle of the Faculty of Sciences of the National University of Education Enrique Guzmán y Valle, Chosica, Peru. Semi-attendance mode, with learning based on the theory of connectivism. For the study, the method was experimental because it set the hypotheses out with the variables controlled by a control group and an experimental group. The type of research was applied-observational using SAS software. Research is applied because it seeks to put into practice the knowledge gained to get new knowledge based on the technological findings of basic research (Hernández, S., 2018). The research work was quantitative because it seeks to be governed by the measurement and qualification of the results, this is if the measurement trends would be obtained, which will help the development of new hypotheses and theories, always hand in hand with statistical processes (Arispe, C., 2020). In a quasi-experimental design, two moments called pre-test and post-test prevail for both intact groups, i.e., an experimental group and a control group (Hernández, C.D.C., 2017).

Based on the above, the design was quasi-experimental because the groups of students were intact groups, i.e. they have established groups and were not randomly selected. We worked with two groups: one group called experimental (GE) and the other control group (GC); the procedure was before the development of the statistical content of the subject students were given a pre-test to the control group and the experimental group in order to measure knowledge, skills, and concepts that dominate on Statistics, then statistical content was developed with the help of SAS software for the experimental group and statistical content without SAS statistical software for the control group; finished the experiment, a final test was administered to determine its influence. For the research work, the population was finite and comprised 177 students of cycle III of the Faculty of Sciences of the University of Education Enrique Guzmán y Valle, Lima (see table 1).

Table 1: The Population of Third-cycle Students Taking Statistics

Programs	Sección	Nº
Biology	C2	26
Mathematics and computer science	C9	28
Chemistry	C5	26
Computer Science	C6	30
Mathematics	C1	28
Biology	CA	24
Physics	C7	16
Total		177

Source: own elaboration, 2022

The sample was determined using the non-probabilistic method; in an intentional and arbitrary way, it chose two sections to consider the criteria that all students develop the same subject, have the same contents, is of the same cycle, and have a socioeconomic level. The experimental group comprised 30 students and the control group of 28. Both groups had the same academic background and were guided by the same teacher. (See table 2).

Table 2: Determination of the Sample by Groups

Groups	Secction	Number of Students	Sample (n)
Experimental	C9	28	28
Control	C1	28	28

Source: own elaboration, 2022

The main data collection technique to measure and know the influence of the SAS program in the statistics learning process was the knowledge tests, as well as auxiliary techniques such as checklists and rubrics to know their levels of progress; The instrument was composed of 20 questions on a vigesimal scale of which 8 items corresponded to the content of statistical analysis at a descriptive level, 8 items to the content of linear and multiple regression, correlation and 6 last items to statistical analysis at an inferential level, before being applied its validity and reliability was determined. The content validity was evaluated by judges and the adequacy of the items with the V. Aiken statistic, the results of the judges' rating were 87% on average, and with the V. Aiken coefficient of 0.83 these results gave us the certainty that the instruments were valid content and if they had adequate validity (see table 3).

Table 3: Item Concordance by V. Aiken Statistical Learning Variable

Dimensions	Clarity	Congruence	Context	Domain	Total
Descriptive Level	0.80	0.89	0.80	0.80	0.82
Inferential Level	0.84	0.83	0.83	0.84	0.83
V. AIKEN	0.82	0.86	0.81	0.82	**0.83**

Source: own elaboration, 2022

In Table 3, we observed the criteria and the concordance of items by dimensions, because of the determination with the V. Aiken coefficient (0.83). This value showed that the items had adequate content validity.

Reliability is the degree to which repeated application to the same subject produces the same results. The two-half method with Spearman Brown, which applies to dichotomous instruments, was used for the research. It processed the results with the help of Excel, below are the formula and results (Hernández, S., 2018) (see table 4).

$$R = \frac{2 * r}{1 + r} \quad (e_1)$$

Where:

R= Spearman Brown coefficient.
r = Pearson correlation

Table 4: Reliability Coefficient Results for Pre-test Learning Statistics

		N	%	N° of items (ítems)	Spearman Brown Coefficient
	Valid	15	100	20	0.85
	Excluded	0	0		
	Total	15	100		

Source: own elaboration, 2022

According to table 4, a Spearman Brown coefficient value (0.85) was observed, concluding that the pre-test instrument presented very high reliability and is applicable to the whole study sample.

Table 5: Result of the Post-test Reliability Coefficient for Learning Statistics

		N	%	N° of items (ítems)	Spearman Brown Coefficient
	Valid	15	100	20	0.84
	Excluded	0	0		
	Total	15	100		

Source: own elaboration, 2022

According to table 5, a coefficient value of 0.84 was observed, this value meant that the post-test presented a high reliability, being reliable, coherent, and consistent with its applicability. Thus, for the study, its validity and reliability were demonstrated.

4 Results

In order to obtain the results at the descriptive and inferential level, the data were processed with the support of SPSS software. At the descriptive level, tables and figures are presented that show the averages of the control and experimental groups, as well as the moments of the Pre-test and Post-test. At the inferential level, the normality test with Shapiro Wilk and the hypothesis contrast with T-Student for independent samples are shown:

Table 6: Pre-test Data Analysis Descriptive Statistics Dimension

	Pre-test_GC	Pre-test_GE
Mean	12.75	11.79
Median	13.00	12.00
Mode	11.00	11.00
Standard Deviation	1.60	1.20
Variance	2.56	1.43
Kurtosis	-0.91	0.60
Asymmetry	0.27	0.72
Mínimum	10.00	10.00
Máximum	16.00	15.00
Count	28	28

Source: own elaboration, 2022

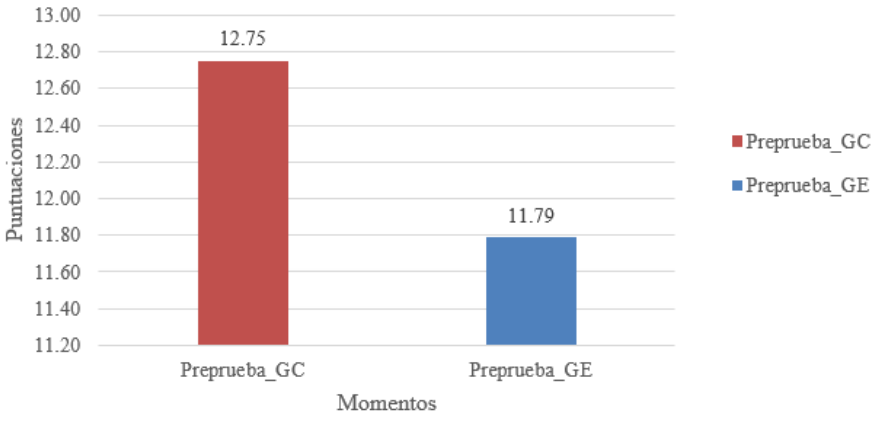

Figure 1: Group Analysis of the Pre-test Statistics Learning Descriptive Statistics Dimension

Source: own elaboration, 2022

The data in table 6 and figure 1 showed scores for the descriptive statistics dimension variable statistics learning at the time of the pre-test, getting a mean of 12.75 in favor of the control group and a mean of 11.79 for the experimental group with standard deviations of 1.6 and 1.2, with a predominance of the pre-test, means for the control group. These results showed that the level of statistics learning in the descriptive dimension is favorable for the control group, which has not yet applied the SAS tool experiment.

Table 7: Data Analysis of the Post-test Dimension at the Inferential Level

	Pos-test_GC	Pos-test_GE
Mean	13.64	15.64
Median	14.00	16.00
Mode	14.00	19.00
Standard dev.	1.16	2.70
Variance	1.35	7.28
Kurtosis	3.61	-1.20
Sample	28	28

Source: own elaboration, 2022

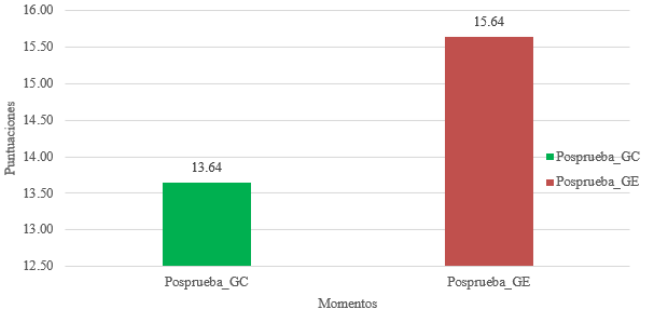

Figure 2: Analysis of Post-test Averages of Statistics Learning Statistics Dimension at the Inferential Level

Source: own elaboration, 2022

According to table 7 and figure 2, the scores of the statistics dimension at the inferential level at the time of the post-test showed an average of 13.64 favorable for the control group and an average of 15.64 for the experimental group with standard deviations of 1.16 and 2.70; according to these results, it was observed that the average compared to the control was higher. These data showed that, after the experiment, there was an influence of the SAS tool in the learning of statistics in the inferential part.

Table 8: Comparative Analysis of Data by Averages for Both Moments

Groups	Pre-test	Pos-test
Control	13.45	13.21
Experimental	12.03	16.44

Source: own elaboration, 2022

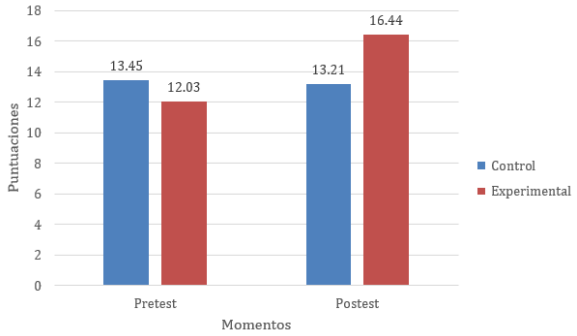

Figure 3: Analysis of Comparative Data between the Control and Experimental Groups

Source: own elaboration, 2022

From table 8 and figure 3, it was observed, in the comparisons of scores of both moments and groups, the results for the pre-test were 13.45 for the experimental group and 12.03 for the control group, observing a small disadvantage for the experimental group; however, in the post-test, an average of 13.21 was got for the control group and 16.44 for the experimental group; these results meant that the average experimental group was superior to the control group because of the application of the SAS tool, evidencing its influence in the learning of statistics.

In order to determine the normality of the distribution of the data collected, the Shapiro Wilk method was used, which applies to samples smaller than 50, and the results were got with the support of the SPSS software. (See table 17)

Table 9: Results of Normality with Shapiro Wilk

	Statistics	n	Sig.
Pre-test	0.354	28	0,000
Pos-test	0.553	28	0,000

Source: own elaboration, 2022

From table 9, we observed the results applied for the pre-test, a statistic of 0.354 with a sig. value of 0.00, as well as for the post-test of 0.553 with a bilateral sig. of 0.00, both results were lower than the value of 0.05 level of significance, concluding that, in the data got, there is a normal distribution. The most appropriate formula to use in the experimental scope hypothesis test was the T-Student for independent samples.

Table 10: T-Student Test, the Influence of the SAS Software on the Learning of Statistics

F	Sig.	T	gl	Sig. (bilateral)	Difference of Means	Error of Difference	95% Confidence Interval	
.598	.598	7.675	54	0.000	1.8 64	.367	.889	3.378
.598	.594	7.575	54	0.000	1.863	.367	.989	3.378

Source: own elaboration, 2022

Table 11: The Probability Distribution for T-Critical

	GE	GC
Mean	16.44	13.21
Degrees of freedom	54	
T-statistic	7.675	
P(value)	0.000	
Critical t-value (two-tailed)	2.021	

Source: own elaboration, 2022

Figure 4: Graphical Representation of t-Calculated and Critical

Source: own elaboration, 2022

In tables 10, 11, and figure 4, it was observed that the value of t-calculated (7.675) was greater than the value of t-critical (2.021), in addition, it was appreciated that the value of probability distribution for two tails is (0.00) and it is lower than the significance value (0.05), then the null hypothesis was rejected and the alternative hypothesis was approved. These results gave the certainty to infer that there was an influence of SAS software on the learning of statistics.

Table 12: Student's t-test Influence of SAS Software on Learning at the Descriptive Level

Levene's test	F	Sig.	T	Gl	Sig. (bilateral)	The difference means	Difference standard error	95% Confidence interval	
equal variances	0.488	.488	5.307	54	0.000	1.571	.296	.978	2.165
Not equal			5.307	53.474	0.000	1.571	.396	.978	2.165

Source: own elaboration, 2022

In table 12, the results of the hypothesis testing at a 95% confidence level processed with the help of SPSS showed that the value of t=5.307 was higher than t-critical 2.009, with a degree of freedom 54 also, the p-value 0.00 was lower than 0.05; therefore, the null hypothesis was rejected and the alternative hypothesis was accepted, concluding that there is a significant influence of SAS Software on the learning of Statistics at the descriptive level.

Table 13: Student's t-test Influence of SAS Software Inferential Part

Levene's test	F	Sig.	T	Gl	Sig. (bilateral)	The difference means	Difference standard error	95% Confidence interval	
equal variances		.678	5,599	54	0.000	1.893	.338	1.215	2.571
was not assumed			,.599	52.599	0.000	1.893	.338	1,214	2.470

Source: own elaboration, 2022

In table 13, the values corresponding to the hypothesis test with the use of the T Student statistic for independent samples and supported with the SPSS software were shown, the results evidenced a value of t- calculated 5.59 at 95% confidence level and the t- table 2.009 with 54 g. l; it was appreciated that the p-value 0.00 was lower than the significance level of 0.05; therefore, the null hypothesis was rejected and the alternative hypothesis was accepted, concluding that there is a significant influence of the SAS Software in the learning of statistics at the inferential level.

Table 14: Student's t-test Difference of Learning Level in Control and Experimental

Levene's test	F	Sig.	T	Gl	Sig. (bilateral)	The difference means	Difference standard error	95% Confidence interval	
equal variances	4.924	.031	5.895	54	0.000	2.643	.448	1.744	3.542
was not assumed			5.895	38.264	0.000	2.643	.448	1.736	3.550

Source: own elaboration, 2022

After testing the hypothesis at a 95% confidence level and 5% significance level, the data was processed with the help of SPSS, and a t-calculated value of 5.895 with 54 degrees was got as well as the calculated t-value of 2.009; it was also clear that p-value 0.00 was lower than 0.05, so the hypothesis was rejected and the true hypothesis was accepted, concluding that there are significant differences in the level of learning of Statistics in the control and experimental groups after the application of SAS.

5 Discussion

As for the validity of the data collection techniques, it was carried out with the method of expert judgment, as well as its adequate validity of the items resulting from the concordance of judges with V. Aiken; the results showed a coincidence of 0.83, determining that they have adequate validity; the reliability of the instruments was determined with the Spearman Brown formula, getting coefficients of 0.85 and 0.84; the items to be measured corresponded to the objectives of the research.

As for the statistical analysis at the descriptive level, tables and figures showed, compare and analyze the results for each control and experimental group, considering the dimensions at the descriptive and inferential levels, these procedures showed results that were favorable to the experimental group, because of the application of the SAS software, it was observed that the students improved their level of learning in the subject of statistics.

As for the analysis at the inferential level, first, the normality test with Shapiro Wilk applicable to samples of less than 50 was carried out; the results of the normality hypothesis test showed our data collected had a normal distribution; the parametric statistic we chose was the T-Student for independent samples compares averages between groups.

As for the comparison with the study of Garzón & Puerta (2022) who create the statistical model of multiple regression using SAS software and propose a tool for analysis of financial indicators from the econometric estimation and their study is not related to education; our research is closely linked to the context of education whose aim was to determine the influence of SAS software in the learning of Statistics through a quasi-experimental design strategy, the results showed that there was the influence of SAS software in the learning of Statistics getting higher averages in favor of the experimental group and promoting more active learning in university students (Garzón Celis, D.C., 2022).

6 Conclusions

Based on the results presented in this research, it is concluded, at 95%, that there is a significant influence of SAS software in the learning of Statistics in university students of the Faculty of Science, this is evidenced in the descriptive analysis of data where the averages got are favorable for the experimental group, also with the hypothesis test using the parametric statistic T- Student for independent samples it was observed that the p-value (0.00) was lower than the significance level (0.05) sufficient reason to statistically infer its influence.

Regarding the first specific hypothesis 1, it is concluded that there was an influence of the SAS software in the learning of the Statistics dimension at a descriptive level, this was evidenced by the results at a descriptive and inferential level where the p-value (0.00) was lower than the significance level (0.05), it was also evidenced in the classroom where the students felt more motivated, creative, interactive, above all, they propitiated a more active learning of statistics.

As for specific hypothesis 2, it was also concluded that there was an influence of the SAS software on the learning of statistics at the inferential level, where the p-value (0.00) was lower than the significance level (0.05). The results showed that, after applying the SAS software, the levels of statistical learning in university students improved significantly in the experimental group, as opposed to the control group where the software was not applied.

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