Characterization of the Performance of Higher Education Students in a Constructivist Learning Based on Two-Factor Analysis Using Inferential Statistics

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ABSTRACT

This study analyzes the level of performance of higher education students in constructivist learning in research based on a two-factor analysis using inferential statistics. In the development of the process, use is made of statistical data organized in tables, carrying out double hypothesis tests in a characterization at the National University of Callao on students from the Faculty of Fisheries and Food Engineering. The National University of Callao is a public institution with a large percentage of students from other nearby and even distant districts from Lima and Callao in Peru. The investigation with inferential statistics, seven tests and statistical results led us to conclude that it is possible to improve the performance of higher education students through constructivist learning since only 5% of the total students failed to improve their performance.

CCS CONCEPTS

• **Applied computing** → Education.

KEYWORDS

Characterization of the performance, Constructivist learning, Higher education students, Inferential statistics, Two-factor analysis

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1 INTRODUCTION

In this opportunity, constructivist learning is analyzed in research in students of the National University of Callao to determine the influence on their performance, for this we use statistics and considerations that allow accepting or rejecting hypotheses.

In the investigations, situations such as unnecessary data impede research in the data collection process and mainly influence the moment in which respondents provide their information, reducing the reliability of the instruments used [1]. Also established the objectives regarding hypotheses we can say that in inferential statistics, a hypothesis test, a hypothesis test or a test of significance is a procedure to judge whether a property that is assumed in a statistical population is compatible with that observed in a sample of said population [1]. In the same way with inferential scope carried out through inferential statistics techniques, to understand the differences between the data of the variables and contrast the related hypotheses [2]. In that sense a hypothesis in the context of inferential statistics is an affirmation about possible results that the researcher expects to find, and the hypothesis contrast (significance test) is the method used to find out if these hypotheses should be accepted or rejected. The idea of hypothesis contrast is whether or not to accept the hypothesis formulated in terms of probability of occurrence, and thus determine whether the population hypothesis is consistent with the data obtained in the sample [2].

A correlational study is applied to discover or clarify the relationships between the groups before the variables of the most significant dimensions for research [2]. Taking into consideration that the inferential statistics that try to test hypotheses from the sample data so that they can be generalized to the population [6]. It uses the probability to infer the results obtained from a sample to the population, that is, it seeks to generalize the results. This generalization will depend on the selection of the sample, which must be representative of the population [3].

The objective of the university is research, where it is important to support the educational activity in constructivist learning and in an interdisciplinary education based on results; support and train teachers; and be linked to family and community [4]. In the research process the sample size determination meets technical-methodological criteria verified from inferential statistics, considering the percentage of error, the level of confidence and the expected distribution of responses [5].

Hernández, Fernández and Baptista (2010), argue that inferential statistics is the branch of statistics that studies the behavior and properties of samples and the possibility and limits of the generalization of the results obtained from those populations they represent. In addition, they maintain that this inductive type generalization is based on probability, which aims to generalize the properties of the population under study, based on the results of a representative sample of said population [6], they also specify that inferential statistics be dedicated to the generation of models, inferences and predictions associated with the phenomena in question, taking into account the randomness of the observations. These inferences can

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take the form of answers to yes / no questions (hypothesis test), estimates of numerical characteristics (estimation), forecasts of future observations, descriptions of association (correlation) or modeling of relationships between variables (regression analysis) [6].

The constructivist teaching-learning process does not have a unique materialization, because it draws on various contributions from different fields of knowledge [7]. However, despite of the drastic changes in the governing paradigm of education and of the challenges to teaching, research in the field of university education on the academic performance, both of students and teachers and institutions, has received little attention, focusing research on primary education and secondary [8].

2 ANALYSIS AND METHODS

2.1 Type, Level and Research Design

Applied research, which we develop, is a process of finding out whether the design of constructivist learning environments, improves the qualifications of the university students, that is, it is an inquiry aimed at producing new knowledge, through individual and collective effort; using the scientific method and the techniques usually admitted in the framework of science. The product of research must authentically increase knowledge in the area studied.

The study is characterized by having a philosophical background; by adopting a set of theories, hypotheses and data; by relying on a body of knowledge obtained about a subject in previous epochs; for dealing with formal, empirical and social systems facts; for raising fertile problems that can be treated with scientific components; by look for goals; and, finally, to use in all circumstances, the scientific method.

The process to solve the scientific research problem raised is the highest-level high level of scientific research that is the experimental and deals with directed observation of the changes and developments produced by the effect of the variables independent in the answer, or dependent variables. It implies the adequate control of independent variables, supposes, therefore, the manipulation of one or more than one variable under rigorous control in order to unravel how and why cause occurs or fails to produce a situation or behavior.

The bifactorial design was applied, fundamentally, because the problem we face is to identify the factors that are significant in the improvement of the qualifications of university students and because bifactorial designs offer us two great advantages:

First, bifactorial designs allow researchers to study the influence of several factors at once. The possibility of studying several factors simultaneously provides researchers with the opportunity to understand a largest segment of the facts that can be studied with a factorial design simple. In addition, the possibility of studying two or more variables at the same time, instead of to carry out two or more studies independently, it is more economical to terms of time and effort.

Second, bifactorial designs allow researchers to study some complex aspect of its object of study, that is, the interactions between variables this refers to the influence of one variable on the effect of another, that is, when the effect of one variable depends on the conditions of another variable. The opportunity to study interactions increases the chances of the researcher for the study of important scientific problems.

2.2 Population and Sample

The approximately 24,000 students of the National University of Callao that enrolled between the academic semesters 2006-A and 2006-B., represent the population of origin The accessible population is represented by, approximately, 2,400 students who enrolled in the Professional Fishing Engineering Schools and of Food Engineering of the Faculty of Fisheries and Food Engineering of the National University of Callao between the academic semesters 2006-A and 2006-B.

The representative part of the accessible population, obtained in order to describe Investigate their properties with a high degree of precision. It is based on or supports the laws of statistical regularity, the inertia of large numbers and the permanence of small numbers

The selection of the units of the sample was made based on a criterion formed by the researcher about the properties of the population accessible to the generalization. The selection of the levels of each independent variable was made randomly; it is say, that each one of the Academic Areas of the Current Curricula of the Schools Fisheries and Food Engineering professionals have had the same possibilities of being extracted and being part of the experimental sample.

The selection of the subjects of the academic areas drawn, also, have been extracted from those belonging to three areas (basic sciences, science engineering and social sciences) by lottery, to avoid possible sources of disability. As the two-factor design involves dividing the sample into six subgroups (three experimental and three controls), the sample was formed with students who were enrolled in three subjects of each Professional School and each area of the Curriculum, for example, like this:

The assignment of the experimental units to each control or experimental group was preformed, that is, each member or individual of the experimental sample, previously, he had to have approved the respective prerequisites and enrolled in one of the six subjects.

The sample sizes for each academic semester, measured in number of students, from each experimental and control level; as shown in the table 1 and table 2

Therefore, the sample size in the academic semester 2006-A was 242 and in the semester academic 2006-B was 217; totaling 459 students and they were assigned and distributed in the three experimental groups and the three control groups.

2.3 Data Processing

The response data, that is, the grades of the university students, have been registered, after the application of the instrument, in specially constructed spreadsheets for the study. The experimental units at the beginning of the study were 242 distributed in the subgroups, as can be seen in table 3, table 4 and the analysis of variance I table 5 below.

Source: Elaboration for the study and based on the final notes. Semester 2006-A

Source: Elaboration for the bifactorial design 2 x 3 and based on the final notes, semester 2006_A

Table 1: Sample sizes by experimental level and by type of subjects in the academic semester 2006-A

		TYPES OF SUBJECT		
INDEPENDENT VARIABLES	LEVELS	BASIC SCIENCES	ENGINEERING SCIENCES	SOCIAL SCIENCES
	TRADITIONAL (CONTROLS)	MATHEMATICS III G1=33	THERMODINAMIC G2=42	METHODOLOGY OF COMMUNICATION G3=46
LEARNING ENVIRONMENT	CONSTRUCTIVIST (EXPERIMENTAL)	PHYSICAL II G4=45	TOPOGRAPHY G5=32	CIENTIFIC INVESTIGATION METHODOLOGY G6=44
DEPENDENT VARIABLE		QUALIFICATIONS OF THE UNIVERSITY STUDENTS		

Table 2: Sample sizes by experimental level and by types of subjects in the academic semester 2006-B

		TYPES OF SUBJECT		
INDEPENDENT VARIABLES	LEVES	BASIC SCIENCES	ENGINEERING SCIENCES	SOCIAL SCIENCES
	TRADITIONAL (CONTROLS)	MATHEMATICS III G1=40	THERMODINAMIC G2=30	METHODOLOGY OF COMMUNICATION G3=41
LEARNING ENVIRONMENT	CONSTRUCTIVIST (EXPERIMENTAL)	PHYSICAL II G4=44	TOPOGRAPHY G5=36	CIENTIFIC INVESTIGATION METHODOLOGY G6=26
DEPENDENT VARIABLE		QUALIFICATIONS OF THE UNIVERSITY STUDENTS		

If $F_c > F_a$ (n_1, n_2) the null hypotheses should be rejected

2.4 Hypothesis test, semester 2006-A

1) Theoretical hypothesis 1: the level of improvement of the students' grades University, improves when the design of learning environments is applied Constructivist in basic science, engineering and social sciences subjects.

2) Statistical hypothesis: in any experiment, if the difference of the qualifications of university students depends on the use of the designs of environments of learning based on constructivist learning, then the greater use of designs of constructivist learning environments, improves the level of variance of the university students' grades at a level of significance of 0.05.

3) Hypothesis null H0: in the experiment yes the difference of the grades of the students university students, depends on the application of the design factor of learning environments constructivist; then the use of the design of learning environments constructivist in the teaching of basic science, engineering and social subjects, does not increase the grades of university students at a level of significance of 0.05

4) Alternative hypothesis Ha: in the experiment yes the difference of the qualifications of the university students, depends on the application of the environment design factor constructivist learning; then the use of the design of learning environments constructivist in the teaching of basic science, engineering and social subjects, increases the qualifications of university students at a level of significance of 0.05.

5) Sample distribution and statistical test as show in the equations

$$H_o : \sigma^2 = \sigma^2$$

$$H_a : \sigma^2 = \sigma^2$$

$$FA{=}(SS_A/(a{-}1))/(SS_x/ab(n{-}1))F_A{-}{-}(MS_A)/MS_C)$$

6) Test statistics

7) Level of significance and rejection area

For $a = 0.05$, reject H_o if $F^3 = 3.92$

8) Verification and conclusion: Since F $_{0.051.138}$ = 7.99 is greater than F = 3.92 we reject the null hypothesis H that the variances between designs of learning environments based or in constructivist learning, they do not differ. Therefore, we accept the alternative hypothesis H, that is, that the variances of constructivist learning differ very much significantly and are explained by their variances.

3 RESULTS

In the significance test, with data from the academic semester 2006-A, for the factor A, DESIGN OF CONSTRUCTIVISTA LEARNING ENVIRONMENTS; as F = 7.99 is greater than $F_{0.051,138}$ = 3.92 we rejected the null hypothesis H that the variances between designs of Learning environments based on constructivist learning do not differ. So, we accept the alternative hypothesis H, that is that the variances of learning to Constructivist differ very significantly and are explained by their variances.

In the significance test, with data from the academic semester 2006-A, for factor B, TYPES OF SUBJECTS OF BASIC, ENGINEERING AND SOCIAL SCIENCES; as F = 0.09 is less than F $_{0.052,138}$ = 3.92, that is, we do not have conclusive evidence for reject the

Table 3: Qualifications of university students ordered in the scheme of the 2-factorial design.

FACTORS		FACTOR B TYPES OF SUBJECTS						SUM
	LEVELS	B1 OF BASIC SCIENCES		B2 OF ENGINEERING SCIENCES		B3 OF SOCIAL SCIENCES		
FACTOR A DESIGN OF LEARNING ENVIRONMENTS	A_1 TRADITIONAL LEARNING (CONTROL)	4	11	7	11	4	8	
		4	11	7	11	4	9	
		7	11	9	11	4	11	
		7	11	9	11	5	11	
		7	11	9	12	5	11	
		8	12	10	12	5	11	
		8	12	11	12	5	11	
		8	12	11	12	6	11	
		11	12	11	12	6	11	
		11	12	11	12	6	11	
		11	13	11	13	6	12	
		11	14	11	13	8	12	
	SUM	97	142	117	142	54	129	691
		7	11	4	8	4	14	
		9	11	5	11	4	15	
		9	11	5	11	9	15	
		9	11	5	11	9	15	
		9	11	5	11	11	15	
		9	11	5	12	11	15	
		9	12	6	14	11	15	
		9	13	6	14	11	15	
		11	13	8	14	12	15	
		11	13	8	15	13	15	
		11	13	8	16	14	15	
		11	14	8	17	14	16	
	SUM	114	144	73	154	123	180	788
	TOTALS	211	286	190	296	187	309	1479

Table 4: Qualifications of university students ordered in the scheme summary of the two-factorial design 2x3

FACTORS	LEVELS	FACTOR B			TOTAL
		B1	B2	B3	
FACTOR A	A1	239	259	193	691
	A2	258	227	303	788
	TOTAL	497	486	496	1479

Table 5: Analysis of variance (ANOVA) for the bifactorial design 2x3

Variant source	Sums of squares	Degrees of freedom	Half of squares	Fc
Teaching technology	65,34	1	65,34	7,99
Types of subjects	1,54	2	0,77	0,09
Interaction AxB	215,60	2	107,80	13,19
Error	1,127.96	138	8,17	
Total	1,410.44	143		

null hypothesis H that the variances of the grades of the students or University among types of subjects differ significantly. Therefore, we not accept the alternative hypothesis H, that is, that the variances between types of subjects they do not differ significantly.

In the significance test, with data from the academic semester 2006-A, for the interaction AxB, DESIGN OF CONSTRUCTIVISTA LEARNING ENVIRONMENTS x TYPES OF SUBJECTS OF BASIC, ENGINEERING AND SOCIAL SCIENCES; as F = 13.19 is greater than $F_{0.052.138}$ = 3,03 we reject the null hypothesis H, that the interactive variances between designs of or Learning environments and types of subjects differ. Therefore, we accept the hypothesis alternative H, that is to say, that the simultaneous variances of the designs of environments of learning and types of subjects differ significantly and are explained by your variances.

In the significance test, with data from the academic semester 2006-A, for the regression between SUBJECTS OF BASIC SCIENCES (Physics II against Mathematics III); as F = 120.49 is greater than $F_{0.051.22}$ = 4.07 we reject the null hypothesis H that the regression or between basic science subjects do not differ. Therefore, we accept H. that is, the regressions between basic science subjects differ very significantly and they are explained by their tendencies.

In the significance test, with data from the academic semester 2006-A, for the regression between ENGINEERING SCIENCE SUBJECTS (Topography against Thermodynamics); as F = 49.83 is greater than $F_{0.051.22}$ = 4.07 we reject the hypothesis null H that the regression between engineering science subjects do not differ. Therefore, we accept the H, it is say that the regressions between engineering science subjects differ very significantly and are explained by their trends.

In the significance test, with data from the academic semester 2006-A, for the regression between SOCIAL SCIENCE SUBJECTS (Methodology of Scientific Research) against Methodology of Communication); as F = 50.25 is greater than F $_{0.051.22}$ = 4.07, we reject the null hypothesis H that the regression between social science subjects or they do not differ. Therefore, we accept H. that is, that the regressions between subjects of Social sciences differ very significantly and are explained by their tendencies.

In the significance test, with data from the academic semester 2006-A, for the regression between EXPERIMENTAL AND CONTROL SUBJECTS; as F = 727.25 is greater than $F_{0.051,22}$ = 4.07, we reject the null hypothesis H that the regression between subjects or Experimental and control do not differ. Therefore, we accept the H, that is, that the regressions between experimental and control subjects differ very significantly and they are explained by their tendencies.

In the significance test, with data from the academic semester 2006-B, for the factor A, DESIGN OF CONSTRUCTIVISTA LEARNING ENVIRONMENTS; as F = 27.31 is greater than $F_{0.051,138}$ = 3.92 we rejected the null hypothesis H that the variances between designs of 0.051,138 or Learning environments based on constructivist learning do not differ. So, we accept the alternative hypothesis H, that is that the variances of learning to Constructivist differ very significantly and are explained by their variances.

In the significance test, with data from the academic semester 2006-B, for factor B, TYPES OF SUBJECTS; as F = 11.48 is greater than $F_{0.052,138}$ = 3.07, that is, we have of sufficient evidence to reject the null H hypothesis that the variances of the University students' grades among types of subjects do not differ. By Therefore, we accept the alternative hypothesis H, that is, the variances between types of Subjects differ significantly.

In the significance test, with data from the academic semester 2006-B, for the interaction AxB, DESIGN OF CONSTRUCTIVISTA LEARNING ENVIRONMENTS x Types of Subjects;

Since F = 4.69 is greater than $F_{0.052.138}$ = 3.07, we reject the null hypothesis H that the Interactive variances between designs of learning environments and types of subjects not they differ. Therefore, we accept the alternative hypothesis H, that is, that the variances to Simultaneous design of learning environments and subject types differ significantly and are explained by their variances.

In the significance test, with data from the academic semester 2006-B for the regression between SUBJECTS OF BASIC SCIENCES (Physics I against Fishing Microbiology); as F = 134.51 is greater than $F_{0.011.22}$ = 7.95 we reject the null hypothesis H that the regression between basic science subjects do not differ. Therefore, we accept H. that is, the regressions between basic science subjects differ very significantly and they are explained by their tendencies.

In the significance test, with data from the academic semester 2006-B, for the regression between SUBJECTS OF ENGINEERING SCIENCES (Topography against Thermodynamics); as F = 330.26 is greater than $F_{0.011.22}$ = 7.95 we reject the null hypothesis H that the regression between engineering science subjects do not differ. Therefore, we accept the H, that is, that the regressions between engineering science subjects differ very much significantly and are explained by their trends.

In the significance test, with data from the academic semester 2006-B, for the regression between SOCIAL SCIENCE SUBJECTS (Methodology of Scientific Research against Methodology of Communication); as F = 54.83 is greater than $F_{0.011.22}$ = 7.95 we reject the null hypothesis H that the regression between social science subjects or they do not differ. Therefore, we accept H. that is, that the regressions between subjects of Social sciences differ very significantly and are explained by their tendencies.

In the significance test, with data from the academic semester 2006-B, for the regression between EXPERIMENTAL SUBJECTS AGAINST CONTROL SUBJECTS; as F = 364.54 is greater than F $_{0.011.22}$ = 7.95 we reject the null hypothesis H that the regression between Experimental and control subjects do not differ. Therefore, we accept the H, that is, to that the regressions between experimental and control subjects differ very significantly and are explained by their trends.

4 DISCUSSION

Our findings allow us to make comparisons with those found by others authors only in regards to the results and not to the design since we have not achieved find sources that contain studies at the experimental level of research scientific Thus, how the theory of Constructivist Learning comes to be one of the axes of Education / Education of the "University of the 21st Century", taking into account two of the main premises: The ability to get involved by the student in their educational / educational work and their perfect suitability in the context of the partner labor of the future.

It is important to consider the role of educational technology from the perspective constructivist Explore the role of constructivism as an educational philosophy that provides a field of pedagogical tests to determine the value of these proposals technological

The constructivist learning emphasizes "the role essentially active of the learner "based on the following characteristics of vision constructivist: a) The importance of prior knowledge, beliefs and motivations of the students; b) The establishment of relationships between knowledge for the construction of conceptual maps and the semantic arrangement of the contents of memory (construction of networks of meaning); c) The ability to build meanings based on restructuring the knowledge that is acquired in accordance with the previous basic conceptions of the subject; and d) Students self-learn by directing their capabilities to certain contents and building themselves the meaning of those contents that have to be processed.

The constructivist conception is organized around three ideas Fundamentals: 1. The student is ultimately responsible for their own process of learning; 2. He is the one who constructs (or rather reconstructs) the knowledge of his group cultural, and this can be an active subject when it manipulates, explores, discovers or invents, even when he reads or listens to the exposition of others; and 3. The function of the teacher is to link the processes of construction of the student with the collective knowledge culturally organized.

One of the most valued goals and pursued within education through the ages, is to teach the students to become autonomous, independent and self-regulated learners, capable of learn to learn. However, at present it seems that precisely what the curricula of all educational levels promote, are highly apprentices dependent on the instructional situation, with many or few knowledge concepts about physics, but with few tools or cognitive tools that serve to face for themselves new learning situations belonging to different domains and useful in the most diverse situations.

Significant solutions to various problems must take place in a constructivist learning environment, that is, in a place where participants manage information resources, printed and visual materials; and tools such as, processing programs, email, search instruments, etc. that allow the construction of said solutions.

Finally, it is expected that the constructivist learning environments continue to have in the future practical applications as it is currently having for the development of constructivist learning environments. This research has a broad relevance not only for issues related to the design of environments, but also for the identification of factors that improve the qualifications of university students.

5 CONCLUSIONS

The design of constructivist learning environments and the types of subjects contribute to improve the qualifications of university students.

The regression analysis show that the level of the qualifications of the students in experimental subjects in basic sciences, engineering sciences and sciences social; they tend to increase significantly.

The variables: design of environments of Constructivist learning and types of subjects exercise an independent influence on improving the qualifications of university students.

The analysis of the two factors model of fixed effects show that the design of constructivist learning environments and have a direct influence on the improvement of the qualifications of university students

The double application of the two-factor designs allow us to assert that the design of constructivist learning environments and the types of subjects improve the qualifications of university students. Thus, 95% of the students who received the experimental treatment, statistically, improved their qualifications.

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