

## PalArch's Journal of Archaeology of Egypt / Egyptology

### Influence Of Environmental Ethics On The Environmental Concerns Of Chemical Engineering Students

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**Jorge Breña, Doris Esenarro, Ciro Rodriguez, Ruben Martinez Cabrera, Elizabeth Luz Segovia Aranibar: Influence Of Environmental Ethics On The Environmental Concerns Of Chemical Engineering Students -- PalArch's Journal Of Archaeology Of Egypt/Egyptology 17(9). ISSN 1567-214x**

**Keywords: ethics, environmental ethics, environmental concerns, chemical engineering**

#### ABSTRACT

This research describes the relationship between environmental ethics and chemical engineering students' environmental concerns in Peruvian universities. The data analysis provides results that confirm that the application of an Environmental Ethics program positively influences chemical engineering students' environmental concerns. The results obtained through self-application instruments in the control and experimental groups, under the application of an intervention program, were subjected to hypothesis tests of differences of means with the Mann-Whitney, Wilcoxon U statistics and applying the Games-Howell post hoc test or univariate generalized linear model post test, based on the information from the Games-Howell post hoc test, it can be stated with a significance level Sig. = 0.200 that there are no statistically significant differences in the medians of the GC pretest, the GC post test, and the G.E. preliminary test; which do differ significantly from the median results of the G.E. From these statistically significant results, it is concluded that the intervention with the environmental ethics program was effective in improving the levels of environmental concerns of Chemical Engineering students belonging to the Peruvian university system.

#### 1. Introduction

This research constitutes a valuable contribution to the professionalization of the Chemical Engineering career in the Peruvian context for the 21st century since it will allow us to know more about the variables that make up a process of re-engineering of the profession within Environmental Education and

considering ethics in all its extension as a transversal axis to be developed in all the training activities. This study is fundamental to promoting socially and environmentally responsible professionals from a reconfiguration of the profession within the paradigm of green chemical engineering, the circular economy, and sustainable production processes. Likewise, the study will characterize and diagnose state-of-the-art chemical engineering students' environmental culture in Peruvian universities. [1,2]

For these reasons, it is necessary and propitious to continue encouraging the development of research not only at an academic level but also at a political and social level that allows improving the educational quality from a change of focus of technocratic engineering purely extractive, towards another sustainable, reflexive approach centered on respect for nature. [2]

Finally, it is necessary to emphasize that within the missionary triptych of Ortega and Gasset concerning the mission of the University that is sustained in its three pillars of teaching, research, and social projection, the work of research is relevant in as much as it tries to transcend the merely technocratic formation and to add a qualitative component referred to the incorporation of its scientific production in this formation, promoted social and environmental awareness to reconfigure the stereotypical thinking of assuming that nature is an inexhaustible source of resources and a bottomless sink for its waste. From that perspective, the mission of teaching allows us to recommend revaluing our ancestral history of always living in harmony with nature. [3]

This article demonstrates the feasibility of introducing, as a transversal axis, ethics at all levels of chemical engineers' professional training. The environmental ethics that must be implemented in the faculties of Chemical Engineering must restructure the formative curriculum to provide eco-training transversally from an indissoluble integration of the socio-environmental dyad to the conscience of the professional as a human being, in such a way that a hidden curriculum is consolidated to guide their professional conduct and thus form professionals who are morally responsible for their actions and with this, it is possible to tend assertively to the construction of a socio-cultural identity that restores harmony between Peruvians and their habitat, so devastated in the last decades. [1] [3].

### **1.1. Scope of Research**

The present investigation wants to contribute to the new educational proposals and the environmental dimension and establish the guidelines to develop a culture of environmental concern in the professional formation of the students of Chemical Engineering of the Peruvian universities[4]. Professional training's ecologization as a strategic choice in chemical engineers' formation is vital in the present research and considers that students should seek the real importance and intentional to their ecological visions within their domains. A significant milestone of this approach is that it assumes that the greening strategy reflects some teleological intention but is aware of its limitations, as it is possible to obtain results different from what was originally intended due to factors such as uncertainty, ambiguity, chaos, and the limits of rationality in the 21st

century. Likewise, the present research's relevance is centered on epistemological considerations because research is being developed to benefit education. At the same time, it is essentially critical and seeks to transform the educational reality of the faculties of Chemical Engineering in Peruvian universities.

As a summary, and not less important, this study is relevant since the goodness of Environmental Education in the formation of chemical engineers in the respective faculties is marginal since the advance of technology and science to optimize extractivism is the fundamental axis of education. Consequently, the professional formation of chemical engineers has to enter through a process of re-engineering; from the permanent evaluation of the environmental dimension in the curricular structures to the incorporation of the conceptual bases of eco-ethics as a determining variable in the explanations that students show in environmental concerns and it becomes essential to research sensitive issues in Environmental Education, focused on the formation of a strong and propositive environmental culture that prepares future professionals for life in reconciliation with nature. [4] [5]

## **2. Methodology**

### **2.1. Type of research**

Based on the study's purposes, it can be classified as applied research, while it is proposed to use a training program in environmental ethics to improve the environmental concerns of the future professionals of Chemical Engineering at a national level.

### **2.2. Level of research**

The present research work is framed within a level of explanatory research because its objective is to study the influence of ethical values in the environmental concerns shown by future Chemical Engineering professionals in a cause-effect relationship. This study has no previous research in the different Peruvian universities. [5]

### **2.3. Method of investigation**

The hypothetical-deductive method was used to advance the research work, which proceeds from a general truth to the knowledge of particular or specific truths. This method will have incidence in the study because the theoretical approaches presented in this work will be the bases to carry out the research, providing information about the studied problem: the foundations of ethics as explanatory variables of the environmental concerns shown by the students of Chemical Engineering of the universities of Peru. [6]

### **2.4. Design and technique**

The scheme of this research, with a quasi-experimental design, is:

1. Design with pre-test and post-test measurements in the control group.
2. The groups established for the research are not randomized and were covered by the technique of quota sampling. [7]

3. The quasi-experimental design is represented as follows:

	pre - test		post - test
G.E.	O <sub>1</sub>	X	O <sub>2</sub>
G.C.	O <sub>3</sub>	-	O <sub>4</sub>

Where:

X = Environmental ethics training program.

O<sub>1</sub>: Pre-test measurements of the environmental concerns variable before applying for the experimental group's environmental ethics training program.

O<sub>2</sub>: Posttest measurements of the environmental concerns variable after applying for the environmental ethics training program in the experimental group.

O<sub>3</sub>: Pretest measurements of environmental concerns in the control group.

O<sub>4</sub>: Post test measurements of the environmental concern variable in the control group.

## 2.5. Sample

Table 1: Sample of students from the control and experimental groups

National Universities	Control group	Experimental group
San Cristobal de Huamanga University	8	8
National University of Engineering	20	20
National University of Callao	12	12
National University of San Agustin	19	19
Universidad Nacional Mayor de San Marcos	10	10
National University of Central Peru	9	9
José Faustino Sánchez Carrión University	10	10
San Luis Gonzaga de Ica National University	12	12
<b>Totals</b>	<b>100</b>	<b>100</b>

Table 1 summarizes the sample of 200 students currently studying in the Chemical Engineering Faculties of their respective Universities, with an average age between 16 and 18 years old. For accessibility limitations to the Universities, it was impossible to establish fixed quotas, and the National University of Trujillo, the National University San Antonio Abad del Cuzco, and the National University Pedro Ruiz Gallo have not participated in the current project, being finally reconfigured the sample as follows.

The researcher decided to work with universities whose professional links with the researcher made it possible to specify the investigation's aims and purposes, which explains the non-random nature of the sample choice. The students who will participate in the sample have been selected according to the university students' criteria to take the 32-hour training course via virtual classrooms related to environmental ethics issues. From a global perspective, the aim is to observe how the training program in environmental ethics influences future professionals' environmental concerns in the Faculties of Chemical Engineering.

### 3. Results

#### 3.1 Caracterización la muestra

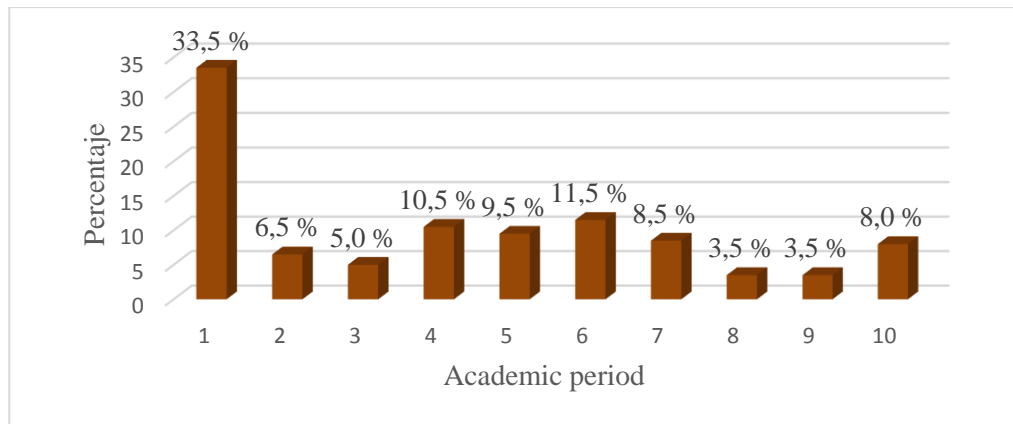


Figure 1 Distribution of students by an academic period of study

Figure 1 reveals the distribution of the sample of individuals by an academic period of study. It should be added that 33.5% is made up of students entering the 2017-II academic period. One explanation for this fact is referred to as the decision to establish the control group with students who did not yet have preconceived ideas about environmental ethics and thus be able to contrast it with those in higher cycles. [8]

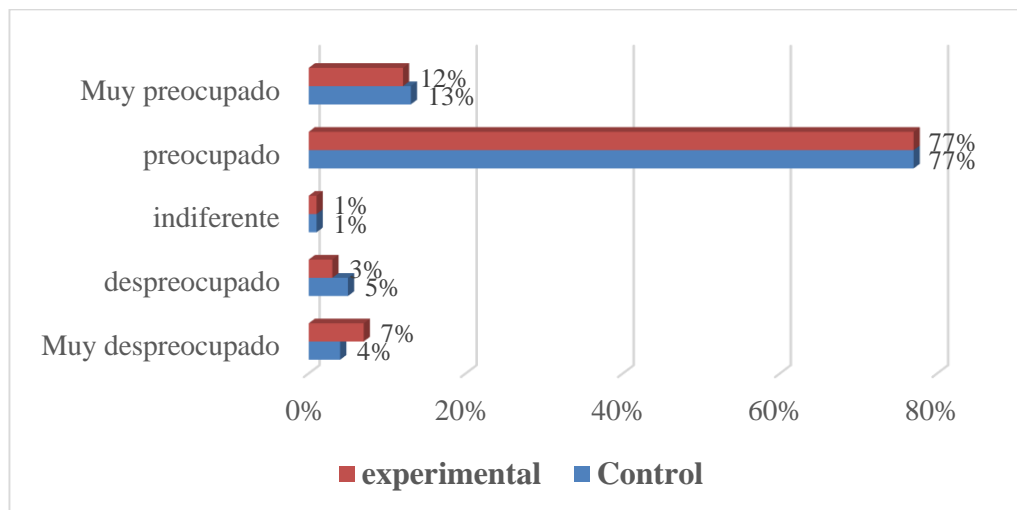


Figure 2 Distribution of students by level of environmental concern

Concerning the question, value your perception of your concerns with environmental problems, Figure 2 reveals that 77% of the participants in the control and experimental groups are concerned, while between 12% and 13% of both groups say they are very concerned. Similar percentages of the students' ratings are disaggregated between the control and experimental

groups, with the students' ratings are between worried and very worried about the environmental problems they perceive.

### 3.2 Results on the reliability of the instrument

Table 2 Reliability Analysis Case Summary

Group	Pretest Control group	Posttest Control group	Pretest Experimental group	Posttest Experimental group	Total Group
Valid	100	100	97	96	393
Excluded	0	0	3	4	7
Cronbach's Alpha	0,815	0,862	0,746	0,756	0,768
N	43	43	43	43	43

In the instrument environmental concerns, the internal consistency analysis of the scale determined from the Cronbach coefficient ( has been verified by groups, by tests, and by the integrity of the information collected. The values collected in tables 3 are between 0.7 and 0.9 and are considered between acceptable and high for research work. On the other hand, those who report a value of 0.8 for the scale's different components. Considering that the research aims to compare the total average value of the instrument in the pre-test and the post-test, we have preferred to assess the overall reliability since we report a total score on the scale (N=43) [9].

### 3.3 Results on the factors of environmental concerns

Table 3 Descriptive statistics for the environmental concerns variable

Statistic	Control Group						Experimental group					
	Pretest			Posttest			Pretest			Posttest		
	Dim.Cogn	Dim.Afect	Dim.Cond	Dim.Cogn	Dim.Afect	Dim.Cond	Dim.Cogn	Dim.Afect	Dim.Cond	Dim.Cogn	Dim.Afect	DimCond.
Media	3,40	3,92	3,89	3,36	3,84	3,74	3,22	3,45	4,06	3,54	4,12	4,09
Medium	3,44	3,86	4,00	3,34	3,86	3,80	3,23	3,44	4,00	3,54	4,14	4,00
Deviation	,41	,46	,54	,45	,56	,55	,37	,27	,41	,339	,384	,46
Min	2,39	3,06	1,80	2,44	2,74	2,40	2,25	2,78	3,00	2,19	2,58	2,60
Max	4,23	4,87	5,00	4,50	5,00	5,00	4,05	4,04	5,00	4,45	4,93	5,00

Table 3 summarizes central tendency measures, variability, maximums, and minimums for the environmental concerns dimension. It can be deduced that, with the control group, no significant changes are observed in the descriptive statistics between the pre-test and the post-test of the averages of the cognitive, affective, and behavioral dimensions.

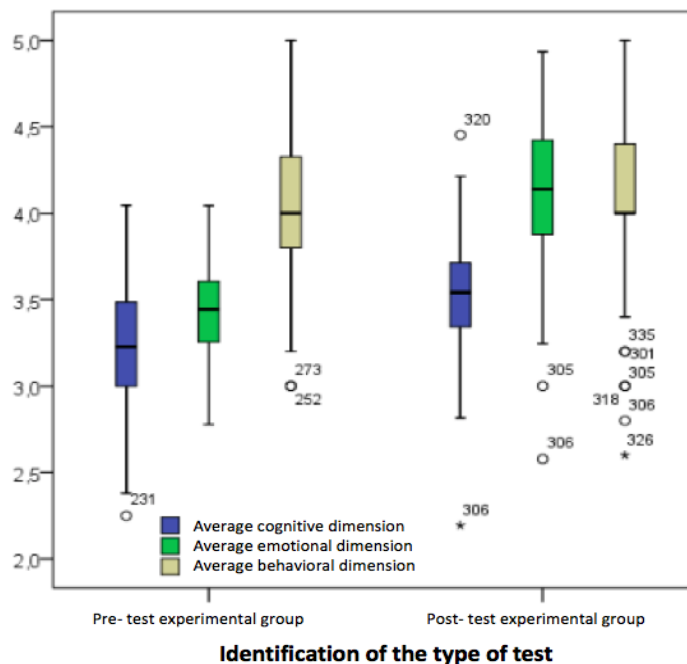


Figure 3 Box and Whisker Diagrams for DC instrument dimensions

From the analysis of figure 3, statistically, significant changes can be deduced in the descriptive statistical data between the pre-test and the post-test of the averages of the cognitive and affective dimensions to the experimental group. Regarding the behavioral dimension, measured with the intention factor of the pro-environmental behavior, it can be observed that the medians and the average do not present visible differences. However, the participants' averages present less dispersion and concentrated in the third quartile of the box and whiskers diagram.

While it is true that ethics is concerned with meta-reflection on human behavior, from the perspective of value judgments, the results show that the volitional of human behavior is complex and the training course of only 35 hours has no significant influence on human behavior.

### 3.4 Descriptive results about the instrument

The information obtained by self-application of the environmental concerns instrument was disaggregated according to the proposed scale, considering that, if the sum of the score obtained is between 43 and 100, the respondent's unfavorable attitudes towards their environmental concerns. If the sum of the scores obtained is between 101 and 158, the respondent has an indifferent attitude towards their environmental concerns. If the sum is between 159 and 215, the respondent has favorable attitudes towards the environment. According to this scale, table 31 reveals that in the pre-test and post-test of the GC, 75% of the participants have an indifferent attitude towards their

environmental concerns, while an average of 25% has a favorable attitude towards their environmental concerns. [10]

Table 4 Dimension-instrument correlation matrix

	Control Group		Experimental group	
	Pretest	Postest	Pretest	Postest
Indifferent attitude	74,0	76,0	75,0	67,0
Favorable attitude	26,0	24,0	25,0	33,0
Total	100,0	100,0	100,0	100,0

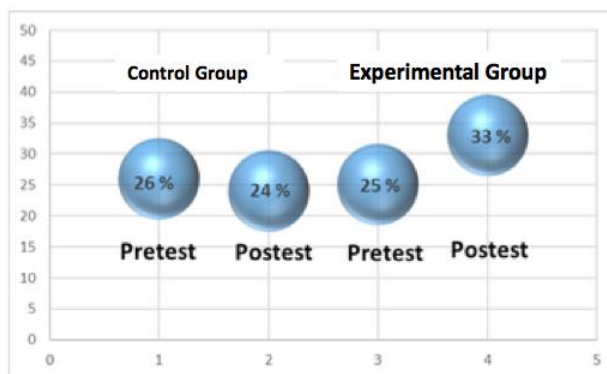


Figure 4 Favorable attitude bubble diagram

In this group, no differences in environmental concerns are evident, both in the pre-test and post-test. E.g., in table 4 and figure 4, a significant change in favorable attitudes towards environmental concerns is evident, increasing from 25% in the pre-test to 33% in the post-test. Analyzing these results, it can be inferred that no respondent expressed an unfavorable attitude towards the environment. [11]

### 3.5 Results on data distribution

Table 5 Test of experimental normality group

Total average of the instrument	Experimental Group Pretest					
	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	gl	Sig.	Statistic	gl	Sig.
	0,072	100	0,200*	0,985	100	0,299
	Experimental Group Postest					
	Kolmogorov-Smirnov			Shapiro-Wilk		
	gl	Sig.	gl	Sig.	gl	Sig.
0,097	100	0,021	0,966	100	0,011	

In the case of the E.G. pretest, table 5 reveals that the Kolmogorov-Smirnov statistic has a value of 0.072 (L.G.=100) and a critical level (Bilateral Asymptotic Significance = 0.200), which being more significant than (Sig.=0.05), it is concluded that there is not enough evidence to reject the assumption of normalized data distribution. It is concluded that the scores of the environmental concern variable fit a normalized data distribution model. In the E.G. post-test, table 34 verifies that the Kolmogorov-Smirnov statistic has a



value of 0.097 (l.g. = 100) and a critical level (bilateral asymptotic significance = 0.021), which being lower than (sig. = 0.05), it is concluded that there is statistically significant evidence for not accepting the assumption of normalized random distribution of data and it is concluded that the scores of the variable environmental concerns do not fit a normal distribution.

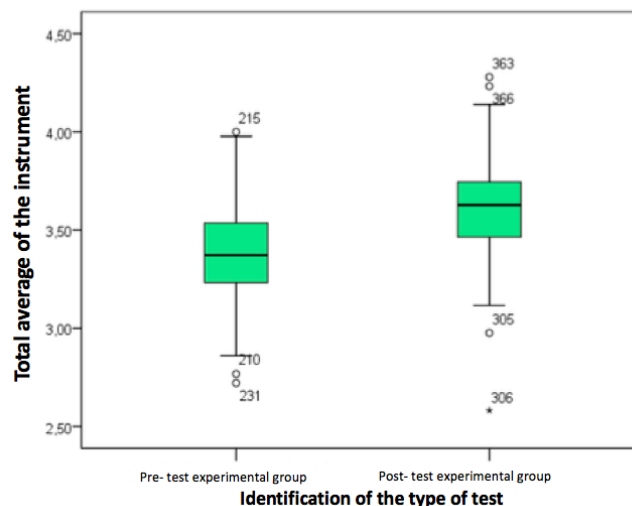


Figure 5 Box and Whisker Diagrams for the experimental group

Analyzing figure 5, a certain similarity can be observed in the distribution of these instrument's overall results, with approximately the same type of dispersion, but with a higher median in the post-test, which presented in each case, outliers.

#### 4. Discussion

Regarding the instrument's reliability, Cronbach's alpha for the instrument's environmental concerns, in CG and EG, and between the pretest and the post test varies between 0.746 and 0.816 and, considering the data as a whole, Cronbach's alpha is 0.769. These results confirm Palavecinos' findings [12]. About the factors and dimensions of the instrument environmental concerns, the results show that referring to anthropocentric views of environmental problems, the view of the personal self (strong anthropocentrism) as a measure of the valuations of nature decreases with the application of the program of training on environmental ethics, transpersonalizing towards a meta personal self. [13].

The environmental concerns are distributed by gender, whose results confirm no significant differences by gender regarding the gradation of concern. On the other hand, it can be observed that the results shown are not in the same line of conclusions as to the investigations of those who in their research work [14]

Contrasting the research hypotheses, the results show in connection with specific hypothesis 1 that there are no differences in G.C. students' environmental concerns between the pretest and the post-test. From the same, the research has proven in connection with the specific hypothesis 2, that there

are no positive differences in environmental concerns in the pretest between the control group and the experimental group of Chemical Engineering students from Peruvian universities, inferring that the students Before applying for the environmental ethics training program, they do not present significant differences in their levels of environmental concern. [5].

La contrastación de las hipótesis específicas 1 y 2 no se presentarse diferencias significativas en el G.C. entre el pretest, el postest y en el pretest entre el G.C. y G.E., son coherentes con el hecho que, sin los mecanismos que promuevan la reflexión ambiental, no se presentan cambios en la conducta ambiental. Asimismo, las contrastaciones de las hipótesis específicas 3 y 4 probaron la influencia positiva que ejercen los cursos de capacitación en ética ambiental sobre las preocupaciones ambientales de alumnos de Ingeniería Química participantes en el G.E.

The result regarding the general hypothesis confirms the conclusions of [14] that in the investigations of his doctoral thesis on Attitude of the students of the Autonomous University of Juan Misael Saracho towards Environmental Education, it proved that 67.8% Of the participants declare that the incorporation of environmental education is decisive to train professionals with social and environmental responsibility, 61.1% declared that laws and regulations on the environment should be stricter.

This chapter of discussion of results can be concluded by arguing that the professional training of Chemical Engineering must be immersed in applied ethics and urgently be incorporated from the pedagogical model and specified in the curricular structure from the first cycles in ethics courses, intermediate cycles in environmental ethics courses and deontology courses at the end of the professional training cycle. These strategies would make it possible to improve the ethics of responsibility and thus offer an ethical professionalization that transcends the status quo and thus force a paradigm shift from engineering based on remediation to another that is focused more on prevention and thus more than search an environmental justice is unavoidable an eco ethic, because of justice sanctions, ethics forms [15].

## 5. Conclusion

Regarding the general hypothesis, the general behavior between the control and experimental groups, the information concerning the summary of the univariate ANOVA of the trend comparisons as part of the Inter-group variation, shows a critical level, Sig. = 0.000, which confirms that if it is possible to affirm that between the pretest and post test of the CG and G.E., the relevant linear correlation is presented. From the information on the Games-Howell post hoc test based on the Duncan statistic to confirm subsets of homogeneous averages, it can be stated with a level of significance, Sig. = 0.200 that there are no statistically significant differences in the medians of the CG pretest, the CG post test, and the pretest of the G.E. ; which do differ significantly from the median results of the G.E. From these statistically significant results, it is concluded that the intervention with the environmental ethics program was

effective in improving the levels of environmental concerns of Chemical Engineering students belonging to the Peruvian university system.

The behavior of G.C. Between the pretest and the post test, the Wilcoxon statistic has a value of  $Z = - 0.788$ , with a critical level (bilateral asymptotic significance) equal to 0.431. Under these results, it can be concluded that there is reliable statistical evidence to affirm that there are no differences regarding the environmental concerns of chemical engineering students belonging to the Peruvian university system between the pretest and post test of the control group.

Regarding the pretest behavior between the G.C. and G.E., the Mann-Whitney U statistic has a value of  $Z = - 1.299$  and a critical level (two-sided asymptotic significance) equal to 0.194. Following these results, it can be concluded that there is reliable statistical evidence to affirm that there are no differences regarding the environmental concerns of chemical engineering students belonging to the Peruvian university system in the pretest between the G.C. and G.E.

Regarding the G.E. pretest and post-test behavior, the Wilcoxon statistic has a value of  $Z = - 5.518$ , with a critical level (bilateral asymptotic significance) equal to 0.000. Under these results, it can be concluded that there is reliable statistical evidence to affirm that there are differences regarding the environmental concerns of chemical engineering students belonging to the Peruvian university system between the pretest of the G.C. and the G.E.

Regarding the post-test between the G.C. and the G.E., the Mann-Whitney U statistic has a value of  $Z = - 4.221$ , with a critical level (bilateral asymptotic significance) equal to 0.000. In correspondence with these results, it can be concluded that there is reliable statistical evidence to affirm that there are differences regarding the environmental concerns of chemical engineering students belonging to the Peruvian university system in the post-test between the control and experimental groups.

## 6. Acknowledgments

This paper has been possible to carry out as research due to the need to obtain and generate knowledge from different professionals. The authors wish to thank our university mentors for their support and guidance.

## References

- Amérigo, M., Aragonés, J., & García, J. Explorando las dimensiones de la preocupación ambiental. Una propuesta integradora. *Journal of Environmental Psychology*, 299-311. 2012.
- Branstetter, J. The Leviathan's Conscience: Hobbesian Human Nature and Moral Judgment. *Political Research Quarterly*, 70(4), 778-789. doi:<https://doi.org/10.1177/1065912917717817>, 2017.
- Bruderer Enzler, H., & Diekmann, A. All talk and no action? An analysis of environmental concern, income, and greenhouse gas emissions in Switzerland. *Energy Research & Social Science*, 51, 12-19. doi:<https://doi.org/10.1016/j.erss.2019.01.001>, 2019.

- Sena, M. Educación ambiental y desarrollo sostenible en la enseñanza básica: análisis de una realidad brasileña en la provincia de minas gerais. Valencia, España. Retrieved diciembre 28, 2015, from <http://roderic.uv.es/handle/10550/45821>, 2015.
- Villarroel gladys e. fermentum mérida - Venezuela - issn 0798-3069 - año 17 - n° 49 - mayo - agosto - 434-454. 434. 2007
- Kowasch, M., & Lippe, D. F. Moral impasses in sustainability education? Empirical results from school geography in Austria and Germany. *Environmental Education Research*, 1-17. doi: <https://doi.org/10.1080/13504622.2018.1557112>, 2019.
- Galetto, L., Torres, C., & Martínez Pastur, G. J. Variable retention harvesting: conceptual analysis according to different environmental ethics and forest valuation. *Galetto et al. Ecological Processes*, 8(40), 1-7. doi:<https://doi.org/10.1186/s13717-019-0195-3>, 2019.
- Doris Esenarro, Ivana Escate, Leslie Anco, Carla Tassara, and Ciro Rodriguez. Proposal for an Ecological Research Center for the Recovery and Revaluation of Biodiversity in the Town of Quichas-Lima, Peru. "International Journal of Environmental Science and Development, ISSN 2010-0264, DOI: 10.18178, Vol. 11, No. 4. 212-216, 2020
- Kowasch, M., & Lippe, D. F. Moral impasses in sustainability education? Empirical results from school geography in Austria and Germany. *Environmental Education Research*, 1-17. doi: <https://doi.org/10.1080/13504622.2018.1557112>, 2019
- Moyano-Díaz, E., Olivos, P., & Aragonés, J. Dimensiones del Comportamiento Proambiental y su Relación con la Conectividad e Identidad Ambientales. *Psico*, 45(3), 369-376, 2014.
- Muresan, H., & Oltean, M. Fruit recognition from images using deep. *Informatica*, 1(10), 26-42. doi:DOI: 10.2478/ausi-2018-0002, 2018.
- Amérigo, M., Aragonés, J., & García, J. Explorando las dimensiones de la preocupación ambiental. Una propuesta integradora. *Journal of Environmental Psychology*, 299-311.2012.
- Sena, M. Educación ambiental y desarrollo sostenible en la enseñanza básica: análisis de una realidad brasileña en la provincia de minas gerais. *Tesis para optar el grado de Doctor en Educación*. Valencia, España. Recuperado el 28 de diciembre de 2015, de <http://roderic.uv.es/handle/10550/45821>, 2015.
- Arenas, Andrés. Aprendizaje olfativo temprano en la abeja (*Apis mellifera*) y su rol en la toma de decisiones relacionadas con la obtención de recursos. Facultad de Ciencias Exactas y Naturales. Universidad de Buenos Aires, 2009
- Huhtala, H. M., & Holma, K. Education of moral beings: the distortion of Habermas' empirical sources. *Ethics and Education*, 1-13. doi:<https://doi.org/10.1080/17449642.2019.1587684>, 2019.