

The Effect of a Stand-Alone Ethics Course in Chilean Engineering Students' Attitudes

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ABSTRACT

Engineering ethics education is taking on increasing importance worldwide, but in Chile the percentage of universities that have a mandatory course concerning ethics is still small. Traditionally, Chilean universities with existing ethics courses teach them using a philosophical or theological perspective, limited to occidental theories, and usually from a Christian point of view. This article studies the impact of a new methodology and technique to teach ethics in Chile: case-based, non-normative, and with a critical-descriptive approach. An empirical study is conducted to assess the relative impact of an ethics class on students individual and inherent moral values and attitudes, and understand the factors that contribute to this impact. Results indicate that even though the importance of religion in Chile is decreasing, it is still a major source of students' ethical principles and moral values. In addition, results suggest that a change in moral values develops when discussions among groups with different points of view occur.

INTRODUCTION

Chile has 180 institutions that provide higher education, 59 of which are colleges or universities. The first 30 universities according to the Chilean ranking, which include the first 10 universities in Industrial Engineering, enroll almost 60 percent of the students seeking higher education. Among those 30 universities, only 36 percent have a mandatory course concerning ethics. "Professional Ethics" is the ethics course most often taught, and it is usually taught from a Christian point of view.

The most frequent topics included in the current Chilean ethics programs are: ethics and society, morals and ethics, ethics principles, occidental ethical theories such as utilitarianism, Kantianism, and virtue ethics (Aristotle), and the code of ethics of an engineer.

A small percentage of Chilean universities have a mandatory course concerning ethics, and the universities that have an existing ethics course in their program usually follow a philo-

sophical or theological perspective from a Christian point of view, not a case-based approach. Hence, it is not surprising that very few ethical cases with a Chilean context have been developed, and that the few courses that use cases rely on American cases.

For this study, a course designed initially for U.S. students and adapted to the Chilean culture was used and taught as an elective course in the Department of Science and Engineering at Universidad Adolfo Ibañez in Chile, with the title "Ethics and Engineering" [1].

The ethics course was designed as a result of a National Science Foundation (NSF) award for "Educational Simulation for Computing and Information Ethics." This course introduces students to a wide range of ethical theories (eastern, western, and contemporary) and addresses a diverse range of ethical challenges facing us in the information age from a non-normative but a critical-descriptive approach [2].

Throughout the course, students have small-group assignments to enhance learning and develop social skills, such as cooperation, and self-confidence [3]. Lectures in the first half of the semester are related to moral values and a variety of ethical theories, along with discussions of ethical cases. For the second half of the course, a learning tool is used to complement the material. This tool is a case-based educational computer simulation, also developed as part of the "Educational Simulation for Computing and Information Ethics" NSF project, for this course specifically and initially for U.S. students. During this part of the semester, each week a new life-like case is discussed. Students grouped in teams use the case-based educational computer simulation to discuss and confront different ethical issues related to the Information Age using the theories learned throughout the course.

In addition, each team needs to model and simulate an ethical issue using agent simulation techniques. This project involves the modelling aspects of a target phenomenon, the utilization of this model to simulate activities for this target phenomenon, and the utilization of ethical principles to assess motivations, processes, or the related consequences of these activities.

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SAMPLE

Data were collected during three consecutive years (Fall 2012, Fall 2013, and Fall 2014) from senior industrial engineering students enrolled in a 16-week course. In addition, data from two controlled groups (Fall 2013 and Fall 2014) were collected to verify the impact from externalities.

The sample consists of 130 students in total; 94 have taken the course, while 36 belong to the control group who had not taken the ethics class. The sample includes female and male Industrial Engineering students, all of them in their senior year, all of them born in Chile with Spanish as their first language. Additional information such as gender, religion, and Chilean region of origin were collected. A summary of the students' demographic data is presented in Table 1. The control groups were from senior year Industrial Engineering elective courses where students work on independent projects in teams.

It is relevant to mention that Catholicism was the official religion in Chile until 1925 and is still the main religion in the country, although its predominance has been declining. According to a survey performed in 2014 by a well known survey company in Chile (Latinobarómetro), the percentage of Catholics has decreased from 74 percent in 1995 to 57 percent in 2013, while Atheists, agnostics, and persons with no religion rose from 8 percent in 1995 to 25 percent in 2013. In the sample group, among all Christians only one student considered himself as Protestant, while the remaining considered themselves as Catholics.

DATA COLLECTED

Students individually completed the Schwartz Value Survey (SVS), which identifies ten basic personal values, in order to build a moral value profile for each student [4]. Each survey was completed two times during the semester: once in the beginning of the semester before any exposure to course material and once at the end of the semester, after all course material had been presented and all group-assignments had been completed.

The 10 basic personal values are organized on four dimensions or underlying motivations (openness to change, self-transcendence, conservation, and self-enhancement). Adjacent personal values are conceptually close to one another, hence their underlying motivations are similar. On the other hand, the further apart the individual values are the more antagonistic are their underlying motivations (Fig. 1).

METHODOLOGY

First, a multivariate analysis of variance, or MANOVA, is used to analyze differences in means among groups when having multiple independent variables and multiple dependent variables; the former are nominal and the latter are quantitative variables. The null hypothesis is that all groups have the same mean for each dependent variable. A significant difference is found when the p-value is less than the confidence level of 0.05 [5].

Sample group	Sex		
	Male	Female	N
Ethics 2012	69 %	31%	30
Ethics 2013	71%	29%	29
Ethics 2014	68%	32%	22
Control group 2013	62%	38%	18
Control group 2014	60%	40%	18
	Religion		
	Christian	None/agnostic/atheist	
Ethics 2012	45%	55%	
Ethics 2013	55%	45%	
Ethics 2014	52%	48%	
Control group 2013	57%	43%	
Control group 2014	55%	45 %	
	Region of origin		
	Capital	Other	
Ethics 2012	95%	5%	
Ethics 2013	98%	2%	
Ethics 2014	90%	10%	
Control group 2013	92%	8%	
Control group 2014	97 %	3%	

Table 1. Summary of students' demographics.

The first comparison is done to the initial Schwartz Value survey data, to detect differences in the value profiles based on the demographic characteristics of each student. The dependent variables are the 10 basic personal values; the independent variables are gender, region of origin, religion, and sample group.

The second comparison uses data from the second SVS, to detect differences in the final value profiles of each student based on their demographic characteristics and the characteristics of the team they conformed. Each team was characterized based on the demographic characteristics of its members, such as gender composition and religious composition.

Then, to verify the MANOVA results, a Kruskal-Wallis test is applied. This test does not

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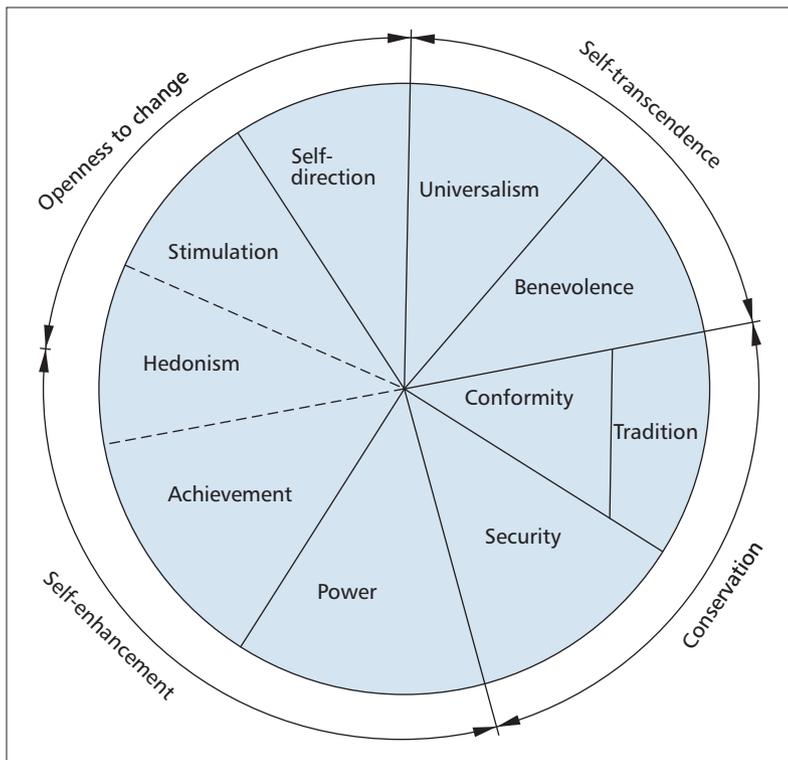


Figure 1. Schwartz Value Survey basic personal values and their underlying motivations.

assume normality, and verifies if data from different groups come from the same population. It is a non-parametric test whose null hypothesis is that all data have the same distribution [5].

Finally, to measure the changes in individual moral values from the beginning to the end of the course, the Wilcoxon signed-ranked test with a confidence level of 0.05 is used. It is a non-parametric test that compares two paired samples. It does not assume that the data comes

from a normally distributed population, works with ordinal data, and since it is a rank-based test, it is robust to outliers [5]. The null hypothesis is that the medians from two dependent samples do not differ significantly. To further identify which group is different, a Dunn's post-test is performed. This test compares the difference in the median for each pair of groups [5].

RESULTS

The multivariate analysis performed on data from the first SVS survey (taken at the beginning of the academic semester) indicates that neither gender nor region of origin has an effect on any of the 10 basic personal values. However, there are statistically significant differences based on sample groups.

Almost all sample groups have no significant differences in the mean scores of their basic personal values, except for sample group Ethics 2012, which has significantly higher mean scores on the personal values of Hedonism and Power. These two individual values lie under the same motivational value, Self-Enhancement (Fig. 2).

The MANOVA test also reveals that religion does significantly influence the value of Tradition, where Christians have higher mean scores than the group conformed for Agnostics, Atheists, or students with no religion.

It is interesting to notice that although no significant differences were found in the value Tradition among the different sample groups, the sample group Ethics 2012, which is the only one that has Christians as a minority, has the lowest mean score.

The Kruskal-Wallis test for independent samples confirms that the values of Power and Hedonism are significantly different when comparing all sample groups, with p-values <0.005. In particular, Ethics 2012 reports higher values than all other sample groups on these basic personal values.

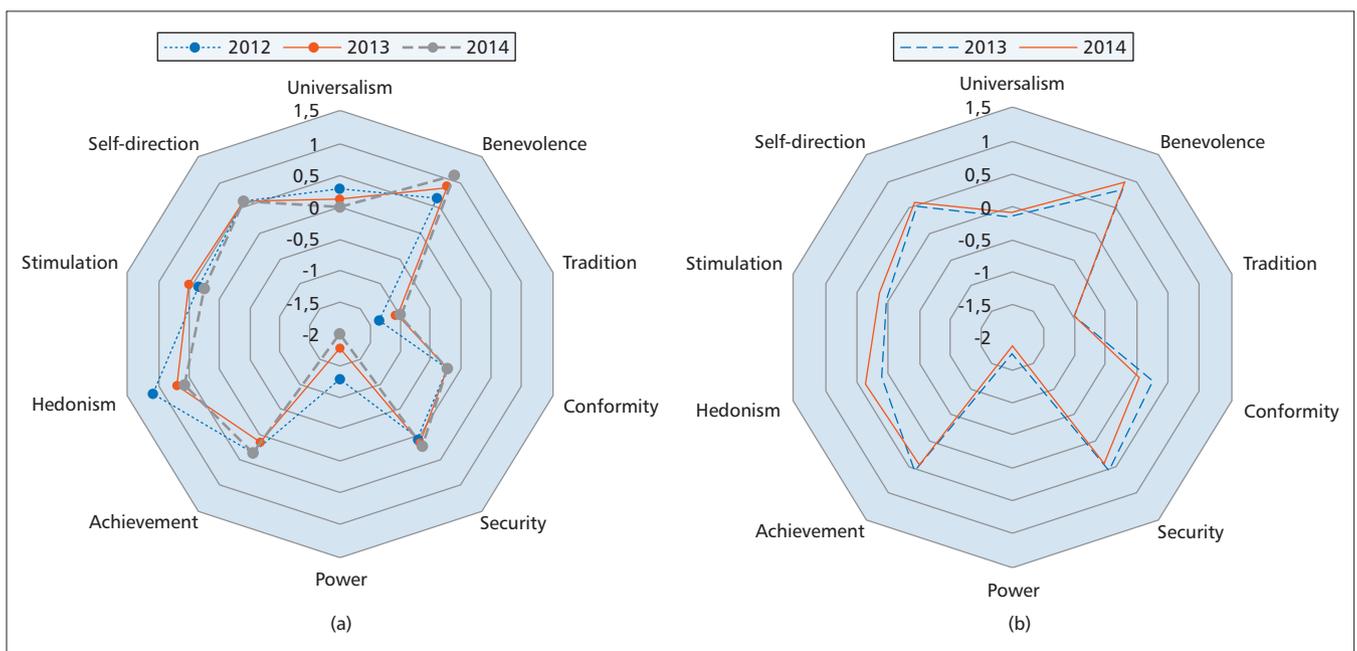


Figure 2. Results of first Schwartz Value Surveys: a) ethics and engineering courses; b) control groups.

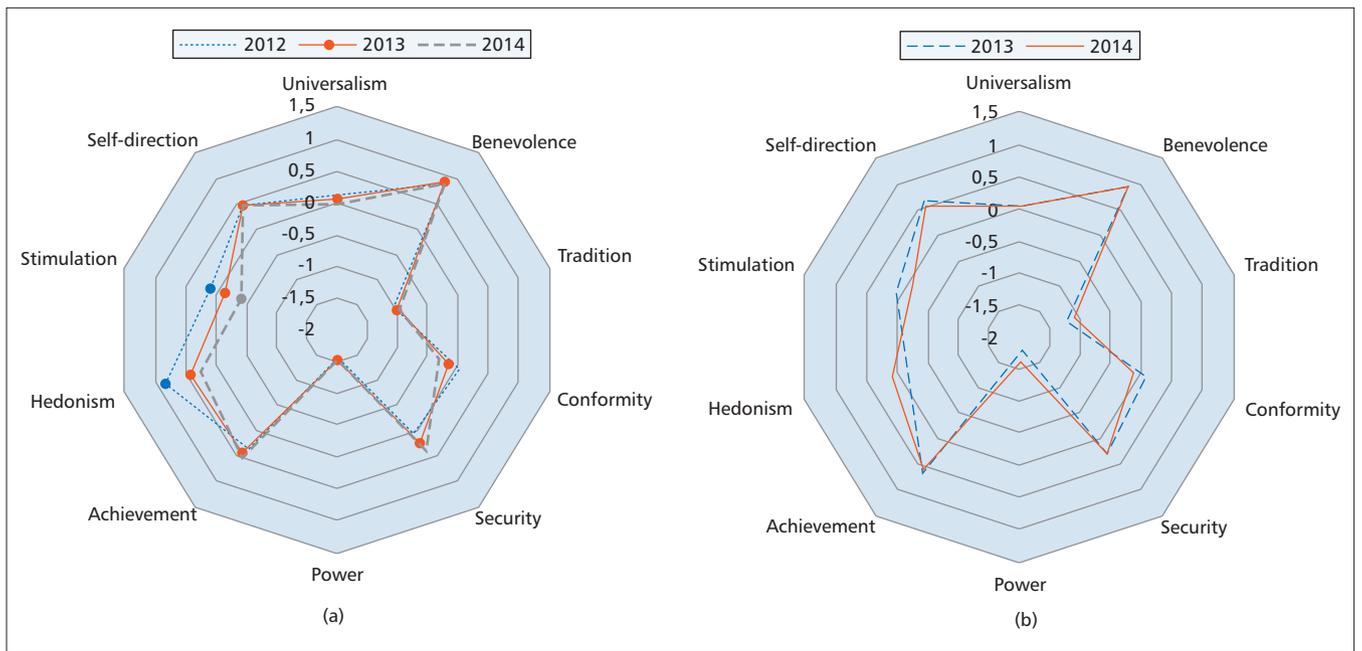


Figure 3. Results of second Schwartz Value Surveys: a) ethics and engineering courses; b) control groups.

The Wilcoxon-Ranked test for dependent samples indicates that no sample group except for Ethics 2012 has significant changes in some of their personal values mean score. In that particular sample group, the values of Power and Stimulation significantly decreased after taking the ethics class. Self-Enhancement and Openness to Change are the underlying motivations of Power and Stimulation, respectively, both having a Personal focus. No changes were significant in the personal values under the motivations of Conservation or Self-Transcendence, which have a social focus. The p-value results are shown in Table 2.

A second MANOVA test applied to the second SVS survey (taken at the end of the ac-

ademic semester) indicates basically the same as the multivariate ANOVA applied to the first SVS. Neither gender, region of origin, nor the team interaction has an effect on any of the 10 basic personal values, but sample group and religion are factors that affect the mean scores of some of them.

Once again, all sample groups except Ethics 2012 have no significant differences in the mean scores of their basic personal values. However, after taking the ethics class, the sample group Ethics 2012 only had higher scores on the personal values of Hedonism (see Fig. 3). Religion remained influencing the value of Tradition.

It is worth mentioning that although after taking the ethics class the only significant differ-

Personal values	Ethics 2012	Ethics 2013	Ethics 2014	Control group 2013	Control group 2014
Power	0.021*	0.318	0.535	0.498	0.533
Achievement	0.100	0.759	0.642	0.702	0.142
Hedonism	0.535	0.610	0.910	0.444	0.769
Stimulation	0.010 *	0.300	0.326	0.709	0.651
Self-direction	0.691	0.226	0.569	0.434	0.914
Universalism	0.496	0.876	0.501	0.779	0.922
Benevolence	0.201	0.401	0.569	0.230	0.217
Tradition	0.148	0.551	0.776	0.305	0.256
Conformity	0.670	0.931	0.816	0.614	0.624
Security	0.306	0.718	0.326	0.768	0.938

Table 2. P-Value results for Wilcoxon test for dependent samples.

Even though the importance of religion in Chile is being decreasing, it is still a major source of students ethical principles and moral values. Different results on the sample groups can be attributed to the only difference that this study finds among groups, Christian minority/majority.

ence occurs in the sample group Ethics 2012 and in particular in the value of Power, all sample groups are more homogeneous in terms of their mean scores.

CONCLUSIONS

This research finds that students who participated in this study, those taking the ethics class as well as those from the control group, have similar initial personal values scores independent of their gender or region of origin. Their value profiles rate higher values related to Openness to Change, such as Self-Direction, Stimulation, and Hedonism, and the value of Benevolence, which is related to Self-Transcendence.

In most of the sample groups the majority of students are Christians except sample group Ethics 2012, which had a majority of Agnostics, Atheists, or those with no religion. Statistically higher initial scores on personal values Power and Hedonism (Self-Enhancement) were found in this particular sample group. In addition, although not statistically different, a lower score on Tradition was found as well.

The statistical analysis also reveals that religion does significantly influence the value of Tradition, where Christians have higher mean scores than the group conformed for Agnostics, Atheists, or students with no religion.

None of the sample groups, including the control groups, with Christians as a majority significantly changed their personal values after taking the ethics class. The only sample group that presented statistically significant changes in some of the personal values' mean scores after taking the ethics class was sample group Ethics 2012. In this particular sample group, the values of Power and Stimulation significantly decreased after taking the ethics class, both related to personal interests or characteristics. And, although not statistically significant, the value of Tradition increased to similar levels as the other sample groups.

Even though the importance of religion in Chile is decreasing, it is still a major source of students' ethical principles and moral values. Different results in the sample groups can be attributed to the only difference that this study finds among groups, Christian minority/majority. Since statistically significant changes occur in the most heterogeneous sample group, in terms of religious beliefs, results suggest that a change in moral values develops when discussions among groups with different points of view occur.

Results are in line with previous research done by the authors [6]. The same experiment was done in a U.S. university and the study concluded that the team interaction with students from different cultures (different points of view) does have an impact on the students' values.

REFERENCES

- [1] R. I. Murrugarra and W. A. Wallace, "A Cross Cultural Comparison of Engineering Ethics Education: Chile and United States," C. Murphy et al., (Eds.), *Engineering Ethics for a Globalized World*, Springer, pp. 189-211, 2015.
- [2] K. R. Fleischmann, R. W. Robbins, and W. A. Wallace, "Information Ethics Education in a Multicultural World," *J. Information Systems Education*, vol. 22, no. 3, 2011, pp. 191-202.
- [3] K. T. Henson., *Curriculum Planning: Integrating Multiculturalism, Constructivism, and Education Reform, Fifth Edition*, Waveland Press, Long Grove, IL, 2015.
- [4] S. H. Schwartz et al., "Refining the Theory of Basic Individual Values," *J. Personality and Social Psychology*, vol. 103, no. 4, 2012, pp. 663-88.
- [5] R. C. Martella et al., *Understanding and Interpreting Educational Research*, New York, NY., Guilford Press, 2013.
- [6] R. I. Murrugarra and W. A. Wallace. "Cross-Cultural and Cross-National Impact of Ethics Education on Engineering Students," *Proc. 2014 IEEE Int'l. Symposium on Ethics in Science, Technology and Engineering*, 23-24 May 2014, pp. 1-6.

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