

# **Towards an integration of formal and informal curricula in engineering schools**

**Mario Letelier Sotomayor**

Centre for Research in Creativity and Higher Education,  
Universidad de Santiago de Chile, Santiago, Chile  
mario.letelier@usach.cl

**Rosario Carrasco Benavente**

Centre for Research in Creativity and Higher Education,  
Universidad de Santiago de Chile, Santiago, Chile  
rosario.carrasco@usach.cl

***Abstract:** The present study aims at analyzing the contribution of informal learning to Engineering students' soft skills, exploring different aspects such as the main sources of informal learning associated to students' achievement of soft skill outcomes and the contribution of informal sources to soft skills not explicitly contained in the Institution's mission. Both qualitative and quantitative methods are used to answer these research questions. The context in which this study is being developed is one of great awareness about the achievement of soft skills among Civil Engineering students, which are usually criticized to lack these sorts of outcomes. The results of this study are intended to provide useful feedback for institutional decisions regarding student outcomes and institutional actions related to informal curriculum.*

## **Background**

According to the length of university study programs in Chile, an average student dedicates five or six years to undergraduate studies (this can be less in the case of other types of Higher Education institutions). She or he enters around 18 years old, and therefore, when this student has completed these studies, the length of university years represents around one fourth of that student's lifespan. During this period, the student has experienced biological and emotional changes, and has accumulated intra and interuniversity social experiences, all of which implies a multidimensional personal development that is, to a great extent, unknown, unplanned and absent of any sort of systematic evaluation carried out by universities.

Given this situation, the University of Santiago, which is both researchers' place of work, has gained interest in studying learning outcomes that are not directly explained by the effect of the explicit and formal study program, but which would be associated to informal types of activities that are not associated, credit-based courses, or university certificates. During the next years, these researchers attempt to contribute to the study of informal learning through the following actions:

1. an initial exploratory study (already done in 2008)
2. a research intending to characterize informal sources of learning
3. assessment of learning outcomes gained through informal sources
4. Institutional diagnose and recommendations for acting upon informal curricula

The present study outlined in this document belongs to the second action mentioned above.

The exploratory study's main objective, conducted during 2008, was dedicated to analyze the relevance of informal learning according to experts and alumni's perception. Interviews to experts in Higher Education and alumni of the University of Santiago were conducted. The external experts provided a discussion related to spheres of informal learning, and alumni were invited to describe what, with whom, where did they learn while attending this University. Focus groups with students of another university have also been conducted. The results of these inquiries indicate that the informal sources of learning are considered highly relevant to the student's learning outcomes, contributing to the acquisition of learning outcomes, especially soft skills.

The second stage intends to characterize informal sources of learning among university students from different areas (humanities, health professions, science, etc). Given that Engineering represents around 40% of the total enrolment at this institution, the researchers have decided to start by analyzing the case of the School of Engineering, representing the main purpose of this study. Together with analyzing the University of Santiago, this study also intends to compare results among other universities, in order to identify the role of informal activities in the acquisition of learning outcomes, especially soft skills.

A third stage, still to come, aims at evaluating a set of learning outcomes that are closely related to informal learning. A group of researchers of this University and Centro Interuniversitario de Desarrollo-CINDA are already working on this.

Finally, the results of these previous phases are expected to provide a thorough institutional diagnose and recommendations for acting upon the informal sources of learning identified throughout the study, in order to integrate the informal curricula together with the formal curricula.

This present study comes at a time of increasing awareness of the necessity of achieving soft skills among Engineering professionals, such as oral and written communication, ethics, responsibility, and leadership.

Though undergraduate accreditation and several higher education state-funded projects at different schools of engineering have attempted to improve its quality, especially through the implementation of curricular innovations in the area of soft skills, a recent study indicated that educational innovations in science and technology undergraduate programs would be difficult to implement. According to this study's results, formal activities and the role of faculty (considered as formal agents of the teaching process) in implementing educational improvements would be much slower than expected (Canales, de los Ríos & Letelier, 2008).

Therefore, given that innovations in formal curricula not necessarily translate into educational innovations and acquisition of learning outcomes, it is necessary to explore more about the contributions of informal learning to students learning outcomes, especially soft skills.

## **Theoretical framework**

### **Informal learning and other related terms**

The literature on higher education learning has outlined the importance of educational processes that are not made explicit in a study program, in credit-based courses or certificate. This wide array of activities and dynamics has been considered as aspects that impact on the student's cognitive-intellectual, social, cultural and personal growth. A review at the publications contained in specialized journals constitutes a clear evidence of the importance of studying educational processes that go beyond the explicit and formal realm of the curriculum (see for example, Journal of College Student Development, Review of Research in Education, Youth and Society, Education, The Journal of Higher Education, Change).

In general, many terms have been used to refer to these educational processes, without one sole predominant term. These terms illustrate the complex nature of the students' learning process and the diversity of educational contexts that can act upon the student's growth. Among the concepts frequently used are "non-formal education" (Coombs & Ahmed, 1974), "informal education" (Livingstone, 2000; Schugurensky, 2000), "extracurricular activities" (Gager & White, 2007), "hidden curriculum" (Freire, 2000), and "tacit knowledge" (Sternberg, Okagaki & Jackson, 1990; Wagner & Sternberg, 1985).

According to Coombs and Ahmed (1974), non-formal education refers to the educational process that takes place outside of an institution, in an organized manner, such as community groups. As for informal education, Livingstone (2000) describes it as any activity that involves comprehension, knowledge or abilities that take place outside of educational institutions, or courses or workshops offered by educational or social agencies. It has been repeatedly noted that the distinction between

non-formal and informal learning can be confusing since students can eventually organize activities as part of their daily routine, with which an informal activity is transformed into a non-formal activity.

Tacit knowledge is another term relevant to the purpose of this study, also referring to informal and implicit learning, and associated to practical and instrumental achievement of one's goals. It would be "acquired indirectly and informally, sometimes even not verbalized, but it is essential for one's survival and success in different settings" (Sternberg et al., 1990). Also, though tacit knowledge research has been carried out in non-academic settings, it would matter in academic life and during college years (Wagner & Sternberg, 1985).

In short, the theoretical framework of this study is based on the concept of informal learning, which also acknowledges non-formal and tacit learning that can act simultaneously upon the students' learning process. Therefore, the analysis of informal learning throughout this study is not restricted solely to those activities that lack of any formal organization, but rather extends the notion of informal, including non-formal initiatives as well as tacit knowledge.

### **"Soft" skills and attitudinal outcomes in Higher Education**

Besides hard skills, understood as plain technical skills, soft skills have been recognized as a whole new set of outcomes that should be acquired by students of all ages. There has been a continuous shift from the recognition of technical or merely cognitive skills towards a greater value of personal and interpersonal skills, all of which emphasize attitudes and values to be taught and apprehended by students. One recent example of this is the body of five competencies and three-part foundation of skills and personal qualities that, according to the SCANS report, would be necessary for any job performance. In this report, the five competencies correspond to resources, interpersonal skills, information, systems, and technology. The three-part foundation would require both hard and soft skills, demanding basic skills (such as reading, writing, arithmetic and mathematics), thinking skills (solving problems, knowing how to learn, thinking creatively, for example), and personal qualities (as individual responsibility, self-esteem, sociability) (for more information see <http://wdr.doleta.gov/SCANS/whatwork/whatwork.pdf>).

At a national level, Chilean higher education outcomes contained in the National Commission of Accreditation (Comisión Nacional de Acreditación-CNA) also make explicit reference to these social and personal skills, besides the more traditional and emphasized acquisition of disciplinary knowledge. A revision of the outcomes contained in the documents with assessment and accreditation criteria for each of the professional programs, stresses a student profile articulated by cognitive skills (such as acquisition of theoretical and conceptual knowledge related to the disciplinary field), generic professional skills (as problem solving, oral and written communication, negotiate and establish agreements), and attitudes and values (such as ethics, adapt to new situations, relate to diversity of people, persevere in the accomplishment of personal goals) (for more information see <http://www.cnachile.cl>).

## **Objectives**

The main objective of the present study is to analyze the contribution of informal learning to Engineering students' soft skills among three Engineering Schools.

More specifically, the objectives are:

- Identify the main sources of informal learning associated to students' achievement of soft skill outcomes.
- Analyze the contribution of informal sources to soft skills that are not explicitly contained in the Institution's mission.
- Analyze the relevance of informal learning to students' soft skills outcomes.
- Compare the results obtained in the previous objectives among the three Engineering Schools so as to analyze between universities effects (if results differ according to the university or correspond to a trend shared by these institutions).

## Main questions that guide the study and hypothesis

### Main questions:

- Does informal learning contribute to soft skills in engineering students?
- Which are the main sources of informal learning that contribute to students' soft skills?
- How relevant are informal sources to soft skills learning?
- When compared to formal learning, understood as planned and structured activities contained in the study program, is it possible to identify if either formal or informal sources are more relevant to the acquisition of students' soft skills?

### Hypothesis:

Both formal and informal activities are valuable for the acquisition of soft skills outcomes. These informal sources, which are usually not so acknowledged as formal activities, would be even more valuable to students' soft skills learning than formal curricular activities.

## Methodology

This is a comparative study. Rather than an intra-institutional analysis, the inter-institutional comparison among three Engineering Schools is explored, in which the informal learning sources of engineering students from three different universities are analyzed.

In order to select three comparable Engineering Schools, which would allow further comparison of the results, the following criteria was adopted:

- Similar size of the institution
- Similar size of the Engineering School
- Similar student average score on University Entry Exam (Prueba de Selección Universitaria-PSU)
- Similar institutional positions on national university rankings.

The researchers consider necessary to select three similar institutions given the great diversity of universities that currently offer Civil Engineering programs. Therefore, this selection should provide a better chance for a comparative analysis among relatively similar institutions. The diversity is expressed in aspects such as the minimum university entrance exam score, the size and complexity of the institution (undergraduate and/or graduate level), size and types of engineering programs offered, and the overall position on national university rankings.

Among the diverse Civil Engineer programs taught at these universities, the following programs were selected:

- Electrical Civil Engineer
- Industrial Civil Engineer
- Chemistry Civil Engineer
- Mechanical Civil Engineer

These study programs have been chosen because they represent the oldest Engineering programs at this University, and enroll greater percent of students. In the case of Industrial Engineer, which is relatively new, it has the largest amount of students. Even when there could be differences within different programs, this between-program analysis is not part of the study's objectives.

According to the objectives of this study, a mixed-method approach is used for the recollection and analysis of information. Qualitative analysis, through the application and analysis of focus-groups and individual interviews to students will be carried out at the three Engineering Schools. The main aspects to be explored through these interviews will be the identification of informal sources that contribute to the acquisition of soft skills, how valuable are these informal activities to students' soft skills, identification of soft skills and other learning outcomes related to the action of informal learning but that are not made explicit in the institutional mission, among other aspects.

Focus groups represent the main qualitative instrument of the study. Through these, it is expected to gather in-depth information related to the specific objectives described in this study. Each focus group is expected to be integrated by students of one of the four Civil Engineer programs, attending the same

university. Eligible students shall be those studying 5<sup>th</sup> or 6<sup>th</sup> year of the Civil Engineer program, independent of their age. Since female engineer students are a minority, especially in the case of Mechanical Engineer, it is not plausible to establish focus-groups with a homogeneous distribution of male and female students.

Since the focus-group could restrain students' in providing more personal or confidential information relevant to the study's objectives, three individual interviews will be applied to a random selection of students attending each of the focus groups. It is expected that three individual interviews will be applied per each focus-group.

In addition to the qualitative approach, a student questionnaire has been elaborated, and is expected to be applied among engineering students in the last years of the program (5<sup>th</sup> and 6<sup>th</sup> year). This questionnaire was elaborated by the main researchers and later, three experts participated in the face validity of this instrument, which proved to be a very useful activity and many of their suggestions were incorporated into the final version of this instrument.

The purpose of this quantitative instrument is to characterize the spaces, people, and activities under which students achieve learning outcomes. It is divided in three sections: a first section aims to identify learning outcomes achieved during their attendance to the higher education institution, characterize how these outcomes were developed; a second section assesses how students value learning outcomes; and a third section assesses learning outcomes that students would have expected to enhance during their university years.

The questionnaire is based on a Likert-type scale that measures how much has each type of space, person and activity contributed to the achievement of learning outcomes. The alternatives given for spaces, person and activity are, in part, based on the information provided by the alumni's when they were interviewed during 2008. Also, the spaces, persons and activities included are based on a continuum of formal-informal sources. The information provided by this questionnaire should identify the contribution of formal and informal spaces, persons and activities to the achievement of learning outcomes, as well as identification of soft skills that rely on informal rather formal learning. Therefore, it is expected that the quantitative information provided by the questionnaire should be complemented with the qualitative information obtained in this study, providing a statistical analysis to the students and faculty's perception.

Though higher education research on student development and college impact distinguishes developmental and sociological models, where the first is mainly related to intra-individual changes and the second is more related to inter-individual origins of student change (Pascarella & Terenzini, 2005), this study's main focus is the analysis of inter-individual change. This emphasis allows the analysis of institutional characteristics that students attend, as well as organizational and environmental factors that influence student learning. Therefore, intra-individual change, such as maturity and personal development, is not the main theme analyzed throughout this study.

## **Closing comments**

Based on the preliminary findings obtained throughout the first exploratory study conducted in 2008, it is possible to sustain that this study is highly valuable since the information revealed indicates the existence of very important student learning outcomes, but that wouldn't have been directly related to this University's action. According to focus groups conducted at other institutions, the researchers can affirm that this same finding is also evidenced at other universities.

The schedule proposed will be completed according to the activities outlined in this document.

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