2018 ASEE Annual Conference & Exposition, June 24–27, 2018, Salt Palace Convention Center, Salt Lake City, UT

Paper ID #22481

A Methodology to Involve Students in the Evaluation of an Engineering Curriculum in Design, Entrepreneurship, and Innovation

Miss Isabel Hilliger P.E., Pontificia Universidad Catholica de Chile

Isabel Hilliger is the Associate Director for Assessment and Evaluation at the Engineering Education Division in Pontificia Universidad Católica de Chile (UC). Isabel received a BEng from UC and an MA in Education Policy from Stanford University. She is currently pursuing a PhD in Computer Science at UC-Engineering. Her research theme is the use of instruments and technological tools to analyze the skills engineering graduates need to succeed in entrepreneurial-spirited companies. She has created qualitative and quantitative instruments for engineering assessment. She has also evaluated policy efforts towards engineering diversity and undergraduate research.

Dr. Constanza Miranda Mendoza, Pontificia Universidad Católica de Chile

Constanza Miranda holds a PhD in design with a focus in anthropology from North Carolina State University. While being a Fulbright grantee, Constanza worked as a visiting researcher at the Center for Design Research, Mechanical Engineering Department, at Stanford. Today she is an assistant professor at P.Universidad Católica de Chile's Engineering School. There, she directs the DILAB: the engineering design initiative. Apart from developing the educational program in engineering design and innovation (Major IDI), the DILAB partners with forward thinking organizations to assess real life ill-defined issues. Past personal experiences involve work in industry and for consultancies such as Procorp Santiago, Cooper San Francisco and Continuum Milan. On the other hand Constanza is an entrepreneur in medical devices where she is continuously working in the detection of opportunities for innovation and development of new technologies. Her research work is focused mainly in the area of bio design, engineering-design education and design anthropology methods.

Dr. Mar Pérez-Sanagustín, Pontificia Universidad Católica de Chile

Mar Pérez-Sanagustín is a researcher and Assistant Professor at the Computer Science Department of the Pontificia Universidad Católica de Chile and the Director of the Engineering Education Division at the same university. Her research interests are technology-enhanced learning, engineering education, MOOCs and b-learning.

A Methodology to Involve Students in the Evaluation of an Engineering Curriculum in Design, Entrepreneurship and Innovation

A Methodology to Involve Students in the Evaluation of an Engineering Curriculum in Design, Entrepreneurship and Innovation

Abstract

Engineering schools have created courses and concentrations to train students for entrepreneurship and innovation. Although studies have analyzed how students perceive this type of training, few of them have unveiled its influence on behaviors and career goals. The formative use of the assessment instruments employed is limited, so more efforts are needed to evaluate entrepreneurial training towards its continuous improvement. This article proposes a methodology to involve students in curriculum evaluation so they become partners in curriculum delivery and teaching practices. To explore its benefits, we applied it on a Major focused on engineering design, entrepreneurship and innovation. During classroom sessions of three Major courses, a form was used to generate individual reflections and collective discussions about course methods, learning outcomes and the curriculum path. Findings show that students were capable of formulating improvement actions to enhance curriculum and teaching practices as a group. Implications for other institutions are discussed to promote the application of this participatory approach in curriculum evaluation processes.

1. Introduction

Today, engineering students need to develop a broad range of technical and entrepreneurial skills, such as: the ability to address a real-world problem, to design a technology-based product or service, to work in multidisciplinary teams, to communicate effectively, and to manage risks [1], [2]. To address this need, schools of engineering have created different opportunities to learn entrepreneurial skills and knowledge. Studies have documented: elective face-to-face courses [3], [4], online courses [5], course concentrations [6], [7], capstone experiences [8], [9], and project-based courses embedded in the engineering curriculum [2], [10]–[12].

Most studies on entrepreneurship education have analyzed psychological outcomes, such as self-efficacy and entrepreneurial intent [13]. Few of them have explored short and long-term effects on professional competencies and career goals [14]. Some of them have used classroom assessment techniques and academic records to understand students' conceptions of entrepreneurial learning [15], [16], but more efforts are needed to explore how students learn about entrepreneurship as they develop ownership of their ideas [17].

This article proposes a methodology to involve students in curriculum evaluation as they become owners of their entrepreneurial learning. To explore its benefits, we applied it in a Major focused on design, entrepreneurship and innovation at the school of engineering at Pontificia Universidad Católica de Chile (UC-Engineering). This Major consists in a 100 credit hour concentration of courses for 50 students per cohort. A form was used to generate individual reflections and collective discussions during classroom sessions in three different courses. During this discussions, qualitative information was collected to explore students' understanding on course methods, learning outcomes and the curriculum path.

First, this article presents the proposed methodology and the curriculum in which the methodology was applied. Then, it shows the results of its applications to discuss the implications to adopt this approach to inform curriculum design and evaluation.

2. Involving students in curriculum evaluation

A curriculum is a broad concept. According to Stark and Lattuca (1997), it is not only a subset of courses in a study plan, but also its content, the course sequence, the students, the teaching-learning processes, the evaluations, the resources, and the necessary adjustments to improve its results. Thus, curriculum design and evaluation should consider multiple factors, such as the learning environments and the interactions between teachers and students [18], [19].

Surprisingly, teachers and students are usually not involved in curriculum discussions [20], [21]. Students are often underrepresented in curriculum planning and delivery [22], being less consulted than employers and other stakeholders [23]. Although their engagement in Higher Education practices has become more important in the last decades [24], their influence on curriculum and teaching is still rare [25].

In order to increase students' involvement, Higher Education managers have motivated students to participate in focus groups [20] and questionnaires. (Barnacle and Dall'Alba 2017). However, there is little evidence that these instruments have led to changes in curriculum delivery and teaching practices. On one hand, the feedback provided by focus groups is specific and direct, but they imply significant amount of time and analytical work [20], [26]. On the other hand, questionnaires simplify the complexity of group discussions [27], but they do not necessarily provide good quality feedback. This is partly due to poor response rates and omitted, incomplete or emotional answers at the moment of its application [26], [28].

To collect evidence that could led to teaching and learning improvements, some researchers are proposing participatory approaches based on collaborative agenda among students, teachers and staff. Students become partners to discuss appropriate data collection strategies, to analyze data, and to solve problems as a group [24], [29]. This partnership could take place in many settings, including program meetings and classroom sessions [30]. In a classroom session, students could be asked to provide real time feedback about instruction and assessment practices [31], and to make this feedback actionable, students could be asked to discuss issues as a group, and to rank issues to inform action planning [26].

In this context, this paper proposes a methodology designed to meet the following guiding principles:

- Students become owners of their learning process if they are partners in curriculum delivery and planning.
- Curriculum improvement actions are better formulated by students, teachers and staff as a collective.
- The quality of students' feedback relies on students' consensus, but this consensus should be reach with minimum analytical work and time investment.

Then, the methodology proposed in this paper consists in:

1. Defining a subset of courses that are highly integrated in the curriculum.
2. Implementing classroom activities in these courses to generate individual reflections and group discussions about curriculum and teaching issues.
3. Documenting findings from the final discussion to inform curriculum and teaching decision making.

The principles are fulfilled by:

- Involving students in a real discussion with their peers and teacher about curriculum and teaching practices.
- Restricting data collection of students' feedback to individual and group discussions during a classroom session.

The following sections describe the curriculum in which the methodology was applied for its validation.

3. A Major focused on Design, Entrepreneurship and Innovation

3.1. Context

In 2013, the Chilean National Agency for Innovation and Development (CORFO) launched the New Engineering 2030 initiative. The main goal of this initiative was to finance strategic plans of the country's leading engineering schools to integrate entrepreneurship and innovation into their curriculum (Grose, 2015). For UC-Engineering, the New Engineering 2030 initiative was an opportunity to strengthen existing curricular and extracurricular activities along these lines [32]. The same year New Engineering 2030 was launched, UC-Engineering started imparting a Major focused on design, entrepreneurship and innovation (www.di-lab.cl). This Major consists in 100 credit hours distributed among progressive project-based courses (at UC-Engineering, 1 credit equals to 1 weekly hour of student workload). The aim of these courses is to prepare future engineers capable of detecting real-world problems and implementing innovative technology-based solutions.

3.2. Major goals and objectives

The Major goal is to prepare students to identify and solve social problems by developing technology-based solutions centered on people. Engineers who have graduated from this program should be comfortable with ambiguity and ill-defined challenges by being able to:

- overcome team conflict,
- acquire critical thinking and problem solving capabilities with a bias on making,
- manage information through visual thinking strategies,
- and focus on people-driven innovation,

To develop these abilities, students are redundantly trained in the design process as they work on real world problems that come from counterparts. Since 2013, 30 counterparts have participated in Major courses, including: large businesses, entrepreneurships, non-profit organizations and governmental agencies.

3.3. Strategy to attract students

From a cohort of over 750 students who are enrolled in the engineering core offered by UC-Engineering, the program committee selects around 50 students. To select students, UC-Engineering makes an open call to all students in an admission cohort. Applicants submit a portfolio and an essay that encases their view on engineering design. The portfolio has to include at least two pieces of work that the student has developed individually or as a team. Then, the committee evaluates students' evidence of leadership, passion and commitment to a particular project, rather than technical or specific knowledge of the student.

3.4. Study plan

Figure 1 shows both core and track courses required to complete the Major credits. The design process is present in all engineering disciplines, so the program committee included two courses of different engineering professionalizing tracks to help students articulate with a professional degree. These two courses are worth 20 credit hours. Further professional degrees that students could pursue are:

- Mechanical Engineering,
- Information Technologies and Software Engineering,
- Civil Engineering,
- and Design.

Regarding the courses from the School of Design, this is mainly intended for students that are thinking in getting a double degree or directly defecting towards a career in design.

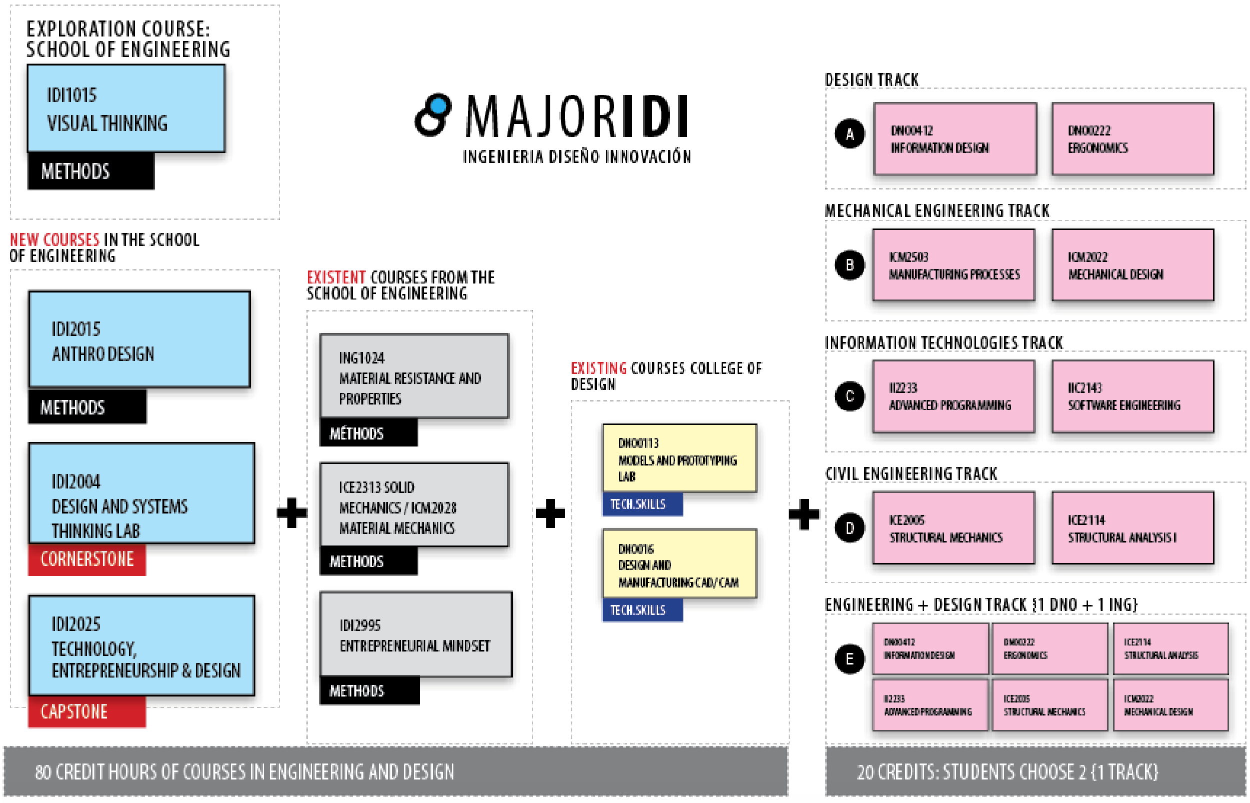

Figure 1. Core-courses and thematic tracks to complete the number of credit hours required by the UC-Engineering Major on design, entrepreneurship and innovation.

Figure 2 shows how the design process addressed throughout the Anthro Design course (IDI2015), the Design and Systems Thinking Lab (IDI2004), and the Capstone course (IDI2025). In the Anthro Design course, students learn tools to deploy ethnographic research, tackle an authentic challenge and detect opportunities focused on the human interface. Then, in the Design and Systems thinking Lab, students learn how to deploy a complete design process cycle-from doing context assessment till developing a proof of concept prototype. Finally, in the Capstone course, students learn to transform a proof of concept prototype to a minimum viable product.

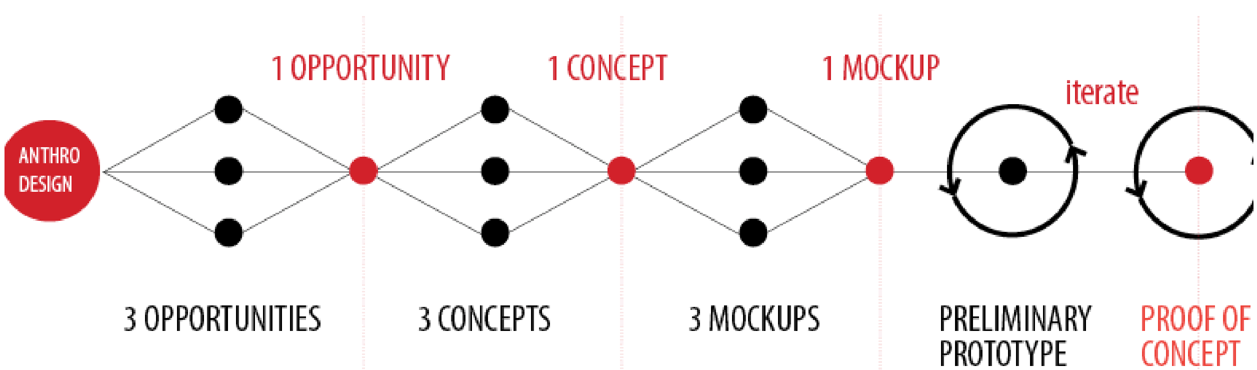

Figure 2. The design process taught in the UC-Engineering Major on design, entrepreneurship and innovation.

4. Methods

The main goal of this study was to explore the benefits of the proposed methodology to involve students in curriculum evaluation by applying it in the UC-Engineering Major.

4.1. Participants and Sample

Table 1 describes the participants and sample of the students who participated in the methodology. From the 76 students who were enrolled in the courses Anthro Design, Design and Systems Thinking Lab and Capstone during the second semester of 2017, 70 participated in the classroom activities part of the proposed methodology.

Table 1. Demographic and academic characteristics of the students enrolled in the subset of courses in which the methodology was applied (second semester of 2017).

	Anthro Design (IDI2015)	Design and Systems Thinking Lab (IDI2004)	Capstone Course on Technology, Entrepreneurship and Design (IDI2025)
N° of students enrolled in the course	53	8	15
N° of students who participated in the methodology	51	6	13
% of female students (*)	47%	50%	33%
% of students admitted to engineering through alternative programs (**)	9%	13%	0%
Admission score (out of 850)	759	756	764
Average of course final grade (out of 7)	5.33	5.36	5.1

Notes:
(*) The proportion of female students at a school level is currently 30%.
(**) About the 11% of the total enrollment is admitted through alternative programs.

4.2. Classroom Activities implemented to Generate Individual and Group Discussions

Figure 3 illustrates the classroom activities that were conducted in the subset of courses. These activities took place before the end of term to avoid the “peak-end rule” (i.e. emotional influences at the end of a course period) [28]. Students had to fill a printed form with information about course methods and learning outcomes (Figure 4). First, they were given time to reflect and fill it individually. Then, they participated in group discussions to fill it collectively. Finally, key findings were accomplished by building group consensus, including the faculty member.

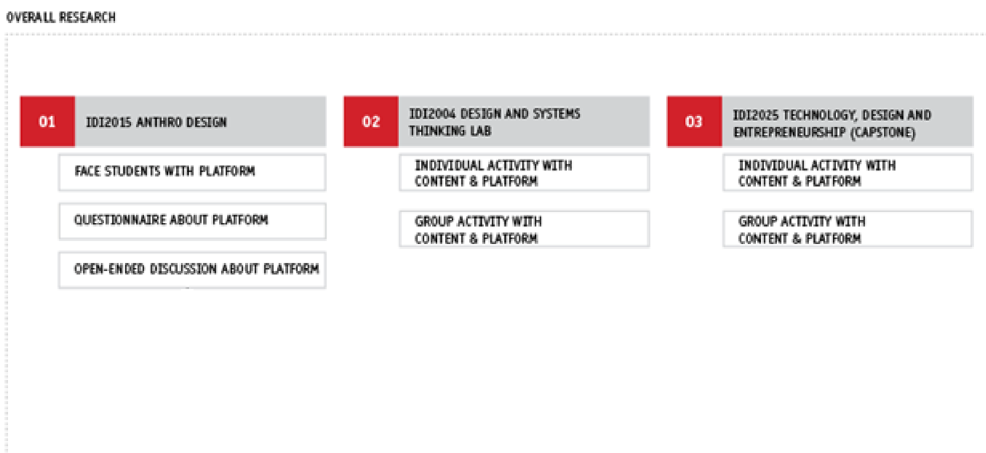

Figure 3. Classroom activities implemented in the subset of courses in which the methodology was applied.

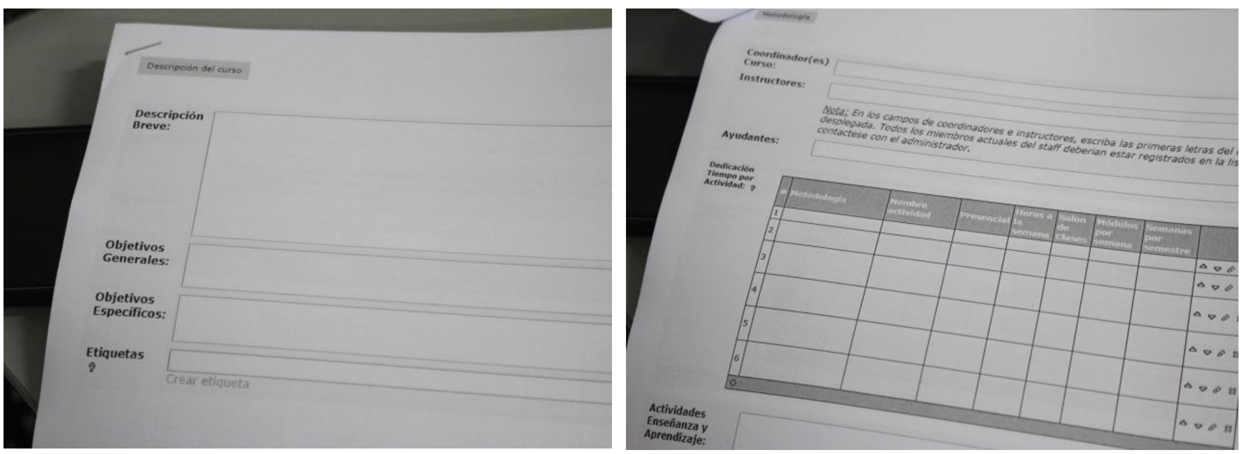

Figure 4. Printed forms used to encourage individual reflections and group discussions (they are in Spanish due to the research site).

4.3. Data gathering techniques and data analysis plan

Three data gathering techniques were use:

- Students' notes in the printed forms used (see Figure 4).
- Classroom notes from both staff members present during the activities.
- Pictures taken during the activities.

Data collected from these three sources was digitalized in Excel and coded by two research assistants. Concerning pictures taken, students signed a consent form when the course starts. This consent form authorized using information collected during classes for research and disseminations, besides including a media release.

5. Results

5.1. Students' ownership of course methods and learning outcomes

Table 2 describes how students defined different elements from the curriculum. From the perspective of the faculty staff, this information was valuable to review and adapt the syllabi for the upcoming semester, particularly in the Capstone course.

Table 2. Course Methods defined by Students in the Subset of Courses in which the Methodology was applied.

Curriculum Elements	Category definition obtained for the Anthro-Design students (IDI2015)	Category definition obtained for the Design Lab course (IDI2004)	Category definition obtained for the Capstone Course (IDI2025)
Brief course description	Brief presentation of the course to account for its central elements, the context addressed, and its relevance within the engineer's training.	This course teaches methodologies to collect and analyze information in order to find a design opportunity. To this opportunity, a solution evolves based on iterations to meet the expectations of a counterpart as well as to test the product.	The course integrates knowledge and skills developed in the major by applying different tools to launch a company or product, covering topics of applied marketing, differentiation, among others.
General objective	General purpose of the course from the student's perspective, that is, what the student will be able to know and do at the end of the course in global terms.	To embrace a design opportunity and develop a user-centered solution by following anthropological approaches and scientific principles to make it innovative.	To develop and validate a viable minimum product and business model in order to validate a project with potential for further development.
Specific objectives	Corresponds to the set of knowledge and skills that students will develop as a result of their participation in the course and that together can achieve the overall goal.	To apply anthropological tools to identify design opportunities, to generate a user-centered solution by prototyping, and to communicate all findings effectively,	To generate business models, to conduct rapid testing, to learn sales skills, to understand marketing strategies, and to manage a project.
Course outcomes	Overlap with specific objectives	Communication skills, problem-solving skills, research skills, negotiation skills, critical thinking.	Communication skills, marketing understanding, sales skills.
Teaching and Learning Activities	They correspond to those pedagogical activities (eg: workshops, projects, laboratories, classes, field trips, etc.) that will allow the development of the competences established in the course.	Practical and theoretical activities, such as prototyping, reverse engineering, research, and readings.	Project presentations during class in order to receive feedback about progress.
Assessment Methods	They correspond to direct and indirect measurements of the knowledge and skills developed by the students as a result of their participation in the course.	Group presentations	Group presentations, reflections on books/readings, video presentation of the product.

5.2. Students' ownership of the curriculum path

Figure 5 describes the curriculum path representation developed during the group discussion generated in the design lab course (IDI2004) (see Figure 6). From left to right, the x-axis indicated the Major Semester, and each form in the whiteboard represents a course. The first form alluded to the Visual Thinking Course (IDI1015), the second to the Anthro Design Course (IDI2015), and the third course in the Design Lab (IDI2004). From the students' perspective, these are the main Major courses were they experience the design process. They left the Capstone Course out because they perceive that design aspects are less covered that business content.

The y-axis illustraed the stress they experience throughout each course. By stress, students meant the amount of workload required to develop the counterpart project. Students described a progression in the work required to fulfill the counterpart needs. Regardless of the workload, students appreciate having a counterpart to make sense of the design process across the curriculum. From their perspective, it is the first time they learn to negotiate with a real client and this negotiation becomes more engaging as they progress in the curriculum path.

Figure 5. Students' representation of the Major Curriculum path. The x-axis indicated the Major Semester and the y-axis indicated the amount of workload they experience throughout each course. From left to right, the first form alluded to the Visual Thinking Course (IDI1015), the second to the Anthro Design Course (IDI2015), and the third course in the Design Lab (IDI2004).

Figure 6. Group discussion at the Design Lab Course (IDI2004). Students were discussing how to represent the curriculum path in the whiteboard by cutting and pasting printed forms.

6. Discussion, Conclusions and Recommendations

We found that a participatory approach could benefit students by allowing them to become owners of their learning process [26]. During the application of the methodology proposed in this paper, students had the opportunity to reflect individually and collectively about course methods and learning outcomes, demonstrating their understanding of teaching practices and the curriculum path.

We also found a participatory approach could benefit faculty staff by providing student feedback directly related with teaching and assessment practices [31]. In this study, students revealed issues in the capstone course regarding a lower workload and a minor focus on the design process compared to prior courses (Figure 5). The detailed information collected was used by the to revise the course syllabus, so design and business aspects seen in this course are balanced.

The application of the methodology demanded minimum amount of time and analytical work. Time was minimized by conducting individual reflections and group discussions during free classroom time (or during transitions between course activities). Concerning analytical work, the printed form was used to classify students' conceptions of curriculum elements, and the group discussions were moderated to extract students' main findings. Still, further work is needed to collect real time feedback because the proposed methodology could only inform improvement actions for future course periods.

Concerning entrepreneurial training for engineers, the application of the proposed methodology could have positive implications. Its implementation would not only benefit students, but also faculty members. According to Hirshfield, Huang-Saad and Libarkin (2017), faculty experience difficulties to integrate entrepreneurship education in engineering settings [11]. By applying this methodology, faculty would collect cost-effective information about how students make sense of this type of training. Besides, its implementation would enable continuous improvement of entrepreneurship courses and concentrations, particularly of its assessment practices. Purzer, Fila and Nataraja (2016) argue that engineering entrepreneurship assessment uses a variety of instruments that do not necessarily inform students' progress or teaching practices [33]. By asking students to reflect individually and collectively, they would provide direct feedback to inform assessment actions.

In conclusion, the methodology described in this paper could motivate all stakeholders to make sense of curriculum efforts to integrate entrepreneurship and innovation. These efforts will benefit students by treating them as partners and change agents; roles that are directly related to entrepreneurial activity. Future work would imply to apply this methodology in other contexts, collecting further information about students' benefits in terms of ownership and curriculum awareness.

7. Acknowledgements

This work was supported by CORFO under grant n°: 14ENI2-26862, and partially supported by the Fondecyt Project nº: 11150231 and the EU Project LALA nº: 586120-EPP-1-2017-1-ES-EPPKA2-CBHE-JP.

8. References

[1] N. Duval-Couetil, E. C. Kisenwether, J. Tranquillo, and J. Wheadon, "Catalyzing the adoption of entrepreneurship education in engineering by aligning outcomes with ABET," in *ASEE Annual Conference & Exhibition,* 2014.

[2] J. Gandhi and D. S. Deardorff, "An Implementation of Innovative Thinking in The Entrepreneurship Cur- riculum for Engineers An Implementation of Continuous Improvement in Instilling Innovative Thinking in The Entrepreneurship Curriculum for Engineers," in *ASEE Annual Conference & Exhibition*, 2014.

[3] J. F. Sullivan, L. E. Carlson, and D. W. Carlson, "Developing Aspiring Engineers into Budding Entrepreneurs : An Invention and Innovation Course," *J. Eng. Educ.*, no. October, pp. 571–576, 2001.

[4] I. Sidhu, K. Singer, M. Suoranta, and C. Johnsson, "Introducing Berkeley Method of Entrepreneurship - a game-based teaching approach," in *74th Annual Meeting of the Academia of Management,* 2014.

[5] J. V Green, E. Program, and D. Technical, "Bringing a technology entrepreneurship curriculum online at the University of Maryland," in *ASEE Annual Conference & Exhibition*, 2011.

[6] C. J. Creed, E. M. Suuberg, and G. P. Crawford, "Engineering Entrepreneurship: An Example of A Paradigm Shift in Engineering Education," *J. Eng. Educ.*, vol. 91, no. April, pp. 185–195, 2002.

[7] S. G. Bilen, E. C. Kisenwether, S. E. Rzasa, and J. C. Wise, "Developing and assessing students' entrepreneurial skills and mind-set," *J. Eng. Educ.*, vol. 94, no. 2, pp. 233–243,

2005.

[8] M. N. A. Bousaba and N. Carolina, “Promoting Entrepreneurial Skills through Senior Design Projects Promoting Entrepreneurial Skills through Senior Design Projects at the University of North Carolina at Charlotte,” 2014.

[9] M. W. Ohland, S. A. Frillman, G. Zhang, C. E. Brawner, and T. K. I. Miller, “The effect of an entrepreneurship program on GPA and retention,” *J. Eng. Educ.*, vol. 93, no. 4, pp. 293–301, 2004.

[10] S. Fredholm *et al.*, “Designing an Engineering Entrepreneurship Curriculum for Olin College,” in *ASEE Annual Conference & Exhibition*, 2002.

[11] L. Hirshfield, A. Huang-Saad, and J. Libarkin, “Mapping Engineering Outcomes to the Lean Launch Curriculum in the Context of Design,” in *ASEE Annual Conference & Exhibition*, 2017.

[12] G. Okudan, J. Finelli, and E. C. Kisenwether, “Entrepreneurial Design Projects: What Type of Projects Are Effective in Improving Student Learning & Enthusiasm?,” in *ASEE*, 2006.

[13] E. C. Rideout and D. O. Gray, “Does entrepreneurship education really work? A review and methodological critique of the empirical literature on the effects of university-based entrepreneurship education,” *J. Small Bus. Manag.*, vol. 51, no. 3, pp. 329–351, 2013.

[14] N. Duval-Couetil, A. Shartrand, and T. Reed, “The role of entrepreneurship program models and experiential activities on engineering student outcomes,” *Adv. Eng. Educ.*, vol. 5, no. 1, pp. 1–27, 2016.

[15] M. Täks, P. Tynjälä, and H. Kukemelk, “Engineering students’ conceptions of entrepreneurial learning as part of their education,” *Eur. J. Eng. Educ.*, vol. 41, no. 1, pp. 53–69, 2015.

[16] M. Täks, P. Tynjälä, M. Toding, H. Kukemelk, and U. Venesaar, “Engineering students’ experiences in studying entrepreneurship,” *J. Eng. Educ.*, vol. 103, no. 4, pp. 573–598, 2014.

[17] J. A. Dobson, E. Jacobs, and L. Dobson, “Toward an Experiential Approach to Entrepreneurship Education,” *J. High. Educ. Theory Pract.*, vol. 17, no. 3, pp. 57–69, 2017.

[18] S. Barradell, S. Barrie, and T. Peseta, “Ways of thinking and practising: Highlighting the complexities of higher education curriculum,” *Innov. Educ. Teach. Int.*, pp. 1–10, 2017.

[19] F. Huang, “The impact of mass and universal higher education on curriculum and instruction: case studies of China,” *High. Educ.*, vol. 74, no. 3, pp. 507–525, 2017.

[20] S. Brooman, S. Darwent, and A. Pimor, “The student voice in higher education curriculum design : is there value in listening ?,” *Innov. Educ. Teach. Int.*, vol. 52, no. 6, pp. 665–676, 2015.

[21] K. Schoepp and B. Tezcan-unal, “Examining the Effectiveness of a Learning Outcomes

Assessment Program : a Four Frames Perspective," *Innov. High. Educ.*, vol. 42, pp. 305–319, 2017.

[22] R. D. Higdon, "Employability: The missing voice: How student and graduate views could be used to develop future higher education policy and inform curricula," *Power Educ.*, vol. 8, no. 2, pp. 176–195, 2016.

[23] C. Bovill, C. J. Bulley, K. Morss, C. Bovill, C. J. Bulley, and K. M. Engaging, "Engaging and empowering first-year students literature," vol. 2517, 2011.

[24] J. Seale, S. Gibson, J. Haynes, and A. Potter, "Power and resistance: Reflections on the rhetoric and reality of using participatory methods to promote student voice and engagement in higher education," *J. Furth. High. Educ.*, vol. 39, no. 4, pp. 534–552, 2015.

[25] M. Healey, A. Jenkins, and J. Lea, "Developing research-based curricula in college-based higher education Developing research-based curricula in Contents," 2014.

[26] T. Varga-Atkins, J. McIsaac, and I. Willis, "Focus Group meets Nominal Group Technique: an effective combination for student evaluation?," *Innov. Educ. Teach. Int.*, vol. 54, no. 4, pp. 289–300, 2017.

[27] R. Barnacle and G. Dall'Alba, "Committed to learn: student engagement and care in higher education," *High. Educ. Res. Dev.*, vol. 36, no. 7, pp. 1326–1338, 2017.

[28] S. Goldfarb and G. Morrison, "Continuous Curricular Feedback: A Formative Evaluation Approach to Curricular Improvement," *Acad. Med.*, vol. 89, no. 2, pp. 264–269, 2014.

[29] M. Fielding, "Transformative approaches to student voice: Theoretical underpinnings, recalcitrant realities," *Br. Educ. Res. J.*, vol. 30, no. 2, pp. 295–311, 2004.

[30] M. Healey, A. Flint, and K. Harrington, "Engagement through partnership: students as partners in learning and teaching in higher education," 2014.

[31] L. E. Adie, J. Willis, and F. M. Van der Kleij, "Diverse perspectives on student agency in classroom assessment," *Aust. Educ. Res.*, vol. 45, no. 1, pp. 1–12, 2018.

[32] S. Celis and I. Hilliger, "Redesigning Engineering Education in Chile : How Selective Institutions Re- spond to an Ambitious National Reform Redesigning engineering education in Chile : How selective institutions," in *2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana*, 2016.

[33] S. Purzer, N. Fila, and K. Nataraja, "Evaluation of Current Assessment Methods in Engineering Entrepreneurship Education," *Adv. Eng. Educ.*, vol. 5, no. 1, pp. 1–41, 2016.