Work in Progress: Engaging Engineering Teaching Staff in Continuous Improvement Process

Ing. Isabel Hilliger, 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 a PhD Candidate in Computer Science at UC-Engineering. Her research theme is the use of methodologies and analytical tools for continuous curriculum improvement in Higher Education. She has created qualitative and quantitative instruments for outcome assessment in enginering education. She has also evaluated policy efforts towards engineering diversity and undergraduate research.

Dr. Sergio Celis, Universidad de Chile

Sergio Celis is an Assistant Professor in the School of Engineering and Sciences at the Universidad de Chile. He conducts research on higher education, with a focus on teaching and learning in STEM fields. His primary research interest is in how multiple forces, internal and external to the institution, influence what and how we teach in colleges and universities. Sergio received his professional degree in industrial engineering at the University of Chile and his Ph.D. in higher education at the University of Michigan.

Dr. Mar Pérez-Sanagustín, Université Paul Sabatier Toulouse III

Mar Pérez-Sanagustín is a researcher and Associate Professor at the Computer Science Department of the Université Paul Sabatier and associate researcher at the Pontificia Universidad Católica de Chile. Her research interests are technology-enhanced learning, engineering education, Self-Regulated Learning, MOOCs and b-learning.

Dr. Jorge Baier, Pontificia Universidad Católica de Chile

He is an associate professor in the Computer Science Department and Associate Dean for Engineering Education at the Engineering School in Pontificia Universidad Católica de Chile. Jorge holds a PhD in Computer Science from the University of Toronto in Canada and a Master's Degree in Engineering Sciences from Pontificia Universidad Católica de Chile. His research focuses on areas of automated reasoning in Artificial Intelligence; specifically, automated planning, search and knowledge representation. Currently his research focuses on understanding how machine learning techniques can be applied to the intelligent decision-making process, on the applicability of reasoning techniques and learning to databases. He is also an assistant researcher at the Millennium Institute for Foundational Research on Data.

WIP: Engaging engineering teaching staff with continuous improvement processes

WIP: Engaging engineering teaching staff in continuous improvement processes

1. Introduction

To demonstrate that future engineers have the skills to succeed in the workplace, many schools have implemented centralized assessment frameworks to collect evidence of outcome attainment [1]. However, it is still unknown whether or not the collection of evidence facilitates the improvement of teaching and learning [2]. Although researchers agree that both outcome assessment tasks and curriculum discussions are key practices of continuous improvement [3], institutions fail at integrating them as part of teaching practices [3], [5].

This Work-In-Progress (WIP) paper presents a methodological approach to understanding teaching staff's engagement with a continuous improvement process which was implemented in the context of ABET accreditation. This process was implemented between 2015 and 2017, alongside important curriculum changes to reinforce technical and professional skills [3], [5] in the engineering school in Pontificia Universidad Católica de Chile (UC-Engineering). To understand how teaching staff engage with continuous improvement, we are developing a case study in which we triangulate three sources of evidence (97 assessment plans, 27 meeting minutes, and 11 semi-structured interviews). We plan to address the following research question: **How does engineering teaching staff engage or disengage with continuous improvement processes?** Along these lines, this WIP paper presents preliminary results regarding the coding of assessment plans to analyze the level of faculty engagement in outcome assessment tasks.

2. Engaging teaching staff in outcome assessment

External demands on higher education have increased over the last two decades due to internationalization, volatile financial environments, technological changes and evolving student demographics [6]. As a consequence, the demand for accountability and outcome-based evidence has increased as well, and many universities and colleges are relying on centralized assessment frameworks and end-of-course surveys that often gather poor-quality data [7]. This has resulted in a larger number of administrative requirements, so teaching staff are dealing with larger workload [6], [8]. Consequently, they spend less time reflecting about curriculum and teaching practices [9], [10], and they resist to fulfilling additional assessment requirements at a program level [4].

Besides lacking opportunities to reflect, most faculty lack opportunities to collect and analyze meaningful learning data due to the complexity of assessing student learning outcomes on a program level [11]. To deal with this challenging but essential task, teaching staff rely on both quantitative (e.g., quiz results, test scores, mid-term students' satisfaction and end-of term evaluations) and qualitative data (e.g., open-ended responses to end of term comments from students and colleagues) to identify teaching and learning problems, often in real-time [7]. Thus, teaching staff use different ways of thinking and practicing assessment to monitor and enhance student learning [12].

In this context, researchers argued that teaching staff—under proper conditions—actively use assessment to improve teaching and learning. First, teaching staff need support from colleagues and institutional leadership, particularly from middle managers [4], [13]. Second, they need opportunities to reflect and engage with others [9], [10]. Third, these opportunities must leverage existing teaching practices, such as faculty luncheons and department committees, to avoid adding up extra workload.

3. Current Research and Data Collection

We adopted a case study as the methodological approach for understanding teaching staff engagement with outcome assessment and continuous improvement [14]. The case study context is the ABET accreditation of five programs at UC-Engineering, the first engineering school in Chile that underwent such an accreditation. UC-Engineering implemented a continuous improvement process between 2015 and 2017 to accredit five academic programs for 11 professional degrees: 1) Civil Engineering, 2) Electrical Engineering, 3) Computer Engineering, 4) Mechanical Engineering, and 5) Chemical Engineering. These programs concentrated about 35% of the undergraduate enrollment, 49% of full-time faculty members (82 out of 169) and 16% of part-time instructors (71 out of 456).

The continuous improvement process was organized in six semesters. Every semester, teaching staff were required to plan the use of course assessments methods to collect evidence of assigned student outcomes (at least two outcomes per course), reporting the results at the end of the semester ('outcome assessment tasks'). These results were transformed into percentages of student outcome attainment to revise them in an end-of-semester meeting ('curriculum discussions'). By 2017, 97 assessment plans were collected from 50 courses (http://bit.ly/2SYxWxc), along with 27 meeting minutes from curriculum discussions (http://bit.ly/2De0hKA). Out of the 50 courses, 37 had to conduct outcome assessment tasks and report results in two or more semesters.

In order to complement the information obtained from assessment plans and meeting minutes, we invited 15 out of 64 teaching staff members who were involved in continuous improvement tasks to participate voluntarily in semi-structured interviews (see interview protocol here: http://bit.ly/2BCrCWc, and informed consent here: http://bit.ly/2E1w3ME). These invitations were sent to a stratified sample of three representatives per professional degree: 1) one faculty member who took the program chair role during the process, and 2) two faculty members who participated in outcome assessment tasks and curriculum discussions for at least two semesters between 2015 and 2017. Finally, 11 interviews were held as part of the sample with two faculty members in Civil Engineering, one in Computer Engineering, three in Electrical Engineering, three in Mechanical Engineering, and two in Chemical Engineering.

In this WIP, we present preliminary results of coding the 97 assessment plans. The coding scheme was developed by three researchers (see Table 1), and kappa's coefficients (κ) were obtained according to Fleiss (1971) [15]. Researchers assigned scores of 0 to 1-point to each plan in four categories: 1) level of detail (κ=0,68), 2) use of non-traditional methods (κ=0,74), 3) use of both direct and indirect methods (κ=0,78), and 4) use of varied methods (κ=0,78). For each category, we considered values equal to 1 as a proxy for teaching staff

engagement, since they represent the use of more demanding tasks to account for outcome attainment (including the use of assessment methods that are more innovative than the ones typically used at UC-Engineering) [7].

Table 1. Coding scheme to analyze assessment plans to collect evidence at a course level.

Codes	Code description
Low level of detail (0)	The assessment plan included minimum information about outcome assessment, without going beyond the course syllabus.
High level of detail (1)	The assessment plan included detailed information about outcome assessment by going beyond the course syllabus.
Traditional methods (0)	The assessment plan alluded to the use of traditional assessment methods, such as exams and homework.
Nontraditional methods (1)	The assessment plan alluded to the use of nontraditional assessment methods, such as oral exams and course projects.
Direct methods (0)	The assessment plans alluded to the use of merely direct assessment methods (i.e. graded assignments).
Direct and indirect methods (1)	The assessment plan alluded to the use of both direct and indirect assessment method to compare learning results with perceived learning.
One method (0)	The assessment plan alluded to one type of assessment method (e.g. exam questions).
Varied methods (1)	The assessment plan alluded to multiple type of assessment methods (e.g. exam questions, homework and lab reports).

4. Preliminary results

Preliminary results show that teaching staff demonstrated different levels of engagement with outcome assessment tasks between 2015 and 2017 (see Figure 1). Although the percentage of plans containing high level of detail was low in all periods, it was observed that the use of nontraditional methods, assessment tools, and indirect methods varied across semesters. First, over 50% of the plans contained non-traditional methods in most semesters, except for the second semester of 2015. Second, over 50% of the plans contained varied assessment methods, except for the second semester of 2016. Third, the percentage of assessment plans reporting direct and indirect methods was the most variable, with highest values in the middle of the process.

5. Discussion and future work

Our preliminary results suggest that there is a great disparity among assessment plans developed by teaching staff. First, most teaching staff demonstrated that they were willing to use non-traditional methods and varied assessment tools to measure student outcome attainment, which aligns with prior research indicating that teaching staff tend to rely on different types of methods to inform their teaching and learning [7], [12]. Second, most of these teachers were not willing to describe these methods and tools exhaustively in their assessment plan since these would be used as accreditation evidence. This might be explained by the fact that even motivated teachers resist to fulfilling assessment requirements at a program level [1], [4].

These preliminary results set the basis for the future analysis, in which we plan to identify mechanisms used to engage and disengage engineering school's teaching staff during a

continuous improvement process. To fulfill this objective, we will analyze meeting memos and semi-structured interviews with a stratified sample of teaching staff. Although the case study analysis will be limited to UC-Engineering, we believe that these results might serve as a guideline for other engineering schools, since engineering programs worldwide have been required to implement continuous improvement processes by ABET accreditation since the early 2000s [3]. Therefore, we would like to receive feedback from the community on our methodological approach and discuss considerations to inform the design and implementation of continuous improvement processes at other institutions.

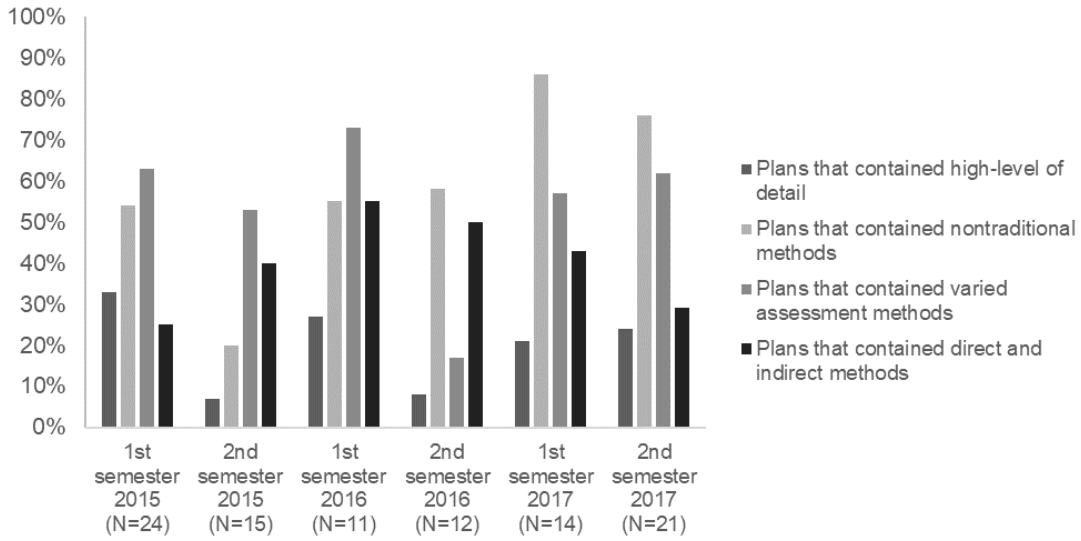

Figure 1. Varying levels of teacher engagement in outcome assessment at a course level (see student outcomes assessed in each period in the following link: http://bit.ly/2SeVzRj)

6. Acknowledgements

This study was funded by CORFO under grant No.: 14ENI2-26862, and partially funded by the LALA project (grant No. 586120-EPP-1-2017-1-ES-EPPKA2-CBHE-JP). This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

7. References

[1] S. Swarat, P. H. Oliver, L. Tran, J. G. Childers, B. Tiwari, and J. L. Babcock, "How Disciplinary Differences Shape Student Learning Outcome Assessment," *AERA Open*, vol. 3, no. 1, p. 233285841769011, 2017.

[2] G. W. G. Bendermacher, M. G. A. oude Egbrink, I. H. A. P. Wolfhagen, and D. H. J. M. Dolmans, "Unravelling quality culture in higher education: a realist review," *High. Educ.*, vol. 73, no. 1, pp. 39–60, 2017.

[3] B. J. Harper and L. R. Lattuca, "Tightening Curricular Connections: CQI and Effective Curriculum Planning," *Res. High. Educ.*, vol. 51, pp. 505–527, 2010.

[4] 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.
[5] L. R. Lattuca, P. T. Terenzini, and J. F. Volkwein, "Engineering Change: A Study of the Impact of EC2000 - Executive Summary," Baltimore, MD, 2006.
[6] S. Shay, "Curricula at the boundaries," *High. Educ.*, vol. 71, no. 6, pp. 767–779, 2016.
[7] J. L. Bouwma-Gearhart and M. T. Hora, "Supporting Faculty I the Era of Accountability: How Postsecondary Leaders Can Facilitate the Meaningful Use of Instructional Data for Continuous Improvement," *J. High. Educ. Manag.*, vol. 31, no. 1, pp. 44–56, 2016.
[8] J. Kenny, "Academic work and performativity," *High. Educ.*, vol. 74, no. 5, pp. 897–913, 2017.
[9] C. J. Finelli, S. R. Daly, and K. M. Richardson, "Bridging the Research-to-Practice Gap: Designing an Institutional Change Plan Using Local Evidence," *J. Eng. Educ.*, vol. 103, no. 2, pp. 331–361, 2014.
[10] 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.
[11] A. M. Walder, "Pedagogical Innovation in Canadian higher education: Professors' perspectives on its effects on teaching and learning," *Stud. Educ. Eval.*, vol. 54, pp. 71–82, 2017.
[12] D. Carless, "Exploring learning-oriented assessment processes," *High. Educ.*, vol. 69, no. 6, pp. 963–976, 2015.
[13] C. M. Branson, M. Franken, and D. Penney, "Middle leadership in higher education," *Educ. Manag. Adm. Leadersh.*, vol. 44, no. 1, pp. 128–145, 2016.
[14] R. K. Yin, *Case Study Research Design and Methods*, 5th ed. Thousand Oaks, CA: Sage Publications, 2014.
[15] J. I. Fleiss, "Measuring Nominal Scale Agreement Among Many Raters," *Psychol. Bull.*, vol. 76, no. 5, pp. 378–382, 1971.