PONTIFICIA UNIVERSIDAD CATOLICA DE CHILE
SCHOOL OF ENGINEERING

FRAMEWORK FOR PROMOTING CONTINUOUS CURRICULUM IMPROVEMENT IN HIGHER EDUCATION USING LEARNING ANALYTICS

ISABEL HILLIGER CARRASCO

Thesis submitted to the Office of Graduate Studies in partial fulfilment of the requirements for the Degree of Doctor in Engineering Sciences

Advisor:
MAR PÉREZ-SANAGUSTÍN

Santiago de Chile, September, 2020

PONTIFICIA UNIVERSIDAD CATOLICA DE CHILE

ESCUELA DE INGENIERIA

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Members of the Committee:

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DRAGAN GAŠEVIĆ DocuSigned by: Dragan Gašević C474EAD56AC4405...

GUSTAVO LAGOS DocuSigned by: Gustavo Lagos C. B558E6FD3B4641F...

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To my husband Sebastián, for encouraging me and supporting me. To my parents and siblings, for always being there for me. To Mar, for believing in me.

In memory of Ximena Carrasco.

ACKNOWLEDGEMENTS

Pese a que mi doctorado comenzó formalmente en agosto del 2016, el camino para convertirme en doctora comenzó mucho antes. Por una parte, mis padres —Gabriela y Guillermo— siempre incentivaron mi curiosidad, desarrollando en mí la capacidad de crear y de esforzarme para conseguir lo que me propusiese alcanzar. Por otra parte, mi hermano y mi hermana —Christian y Gabriela— siempre estuvieron ahí para mí; no sólo para enseñarme a compartir, sino también para enseñarme a debatir y a pensar de forma crítica. Es por esto que, en primer lugar, me gustaría agradecerle a mi familia por su cariño incondicional, y por siempre motivarme a ir más allá.

No obstante, yo nunca hubiese podido iniciar este camino si no fuese por Mar Pérez Sanagustín. Conocí a Mar en diciembre del 2014; una vez me incorporé a la Dirección de Educación en Ingeniería (DEI) de la Pontificia Universidad Católica de Chile. Desde que nos conocimos, Mar me invitó a colaborar en distintos estudios, creyendo en mis habilidades para abordar un problema de investigación, y aportar desde mis conocimientos en educación y evaluación. Más aún, fue ella quién me motivó a realizar un doctorado, desafiándome a formular mis propias preguntas de investigación, y a colaborar con otros investigadores durante la búsqueda de una respuesta. En ese sentido, también estoy muy agradecida de ella; no sólo en su rol de profesora supervisora, sino también de amiga y colega.

Independiente del cariño de mi familia y del empuje de Mar, yo no hubiese sido capaz de completar mi doctorado si no fuese por el amor y constante apoyo de mi marido —Sebastián. En estos últimos cuatro años, él siempre ha estado ahí para mí de distintas maneras: una palabra de aliento, contención, una rica comida al final del día. Agradezco infinitamente su capacidad y generosidad al abordar mi doctorado como un proyecto conjunto, siendo capaz de sobrellevar momentos complejos y de celebrar cada logro.

Me gustaría aprovechar de agradecer también a un sinnúmero de personas que me acompañaron durante mis estudios de doctorado. En primer lugar, me gustaría agradecerle a mi Comité de Tesis, los doctores Sergio Celis, Miguel Nussbaum, Valeria Herskovic, y Gustavo Lagos. Cada uno de los integrantes de este Comité fue sumamente generoso con su conocimiento y su experiencia. Su retroalimentación fue clave para hacer de esta tesis

una contribución significativa, por lo que agradezco haber contado con ellos como modelos a seguir en mi futuro como investigadora.

En segundo lugar, me gustaría agradecer al decano Juan Carlos de la Llera, y al equipo de la DEI — Jorge, Ximena, Constanza, Marjorie y Josefina. Por un lado, agradezco al decano su invitación a volver a la Escuela posterior a mis estudios de magíster en Stanford, ofreciéndome no sólo la oportunidad de retribuir, sino también de crecer como profesional e investigadora. Por otro lado, agradezco la compañía y el apoyo del equipo de la DEI y de su actual director, creciendo junto conmigo en lo que ha sido este camino de vincular la gestión en la educación superior con la investigación educativa.

En tercer lugar, me gustaría agradecer al equipo de u-planner y a su gerente general, Juan Pablo Mena. No sólo me abrieron las puertas para realizar investigación aplicada sobre tecnología, sino que también me permitieron transferir lo aprendido al desarrollo de nuevas soluciones. Además, me conectaron con Laspau, organización afiliada a Harvard donde realicé mi pasantía. De esta organización, agradezco a Angélica Natera, directora ejecutiva de Laspau, por su cálida recepción y por abrirme las puertas a un ecosistema de educación superior de excelencia. Agradezco también a Colleen Silva, Directora Asistente de Innovación Universitaria, por su apoyo durante la pasantía y por su interés en transferir mi investigación a otras instituciones de educación superior en Latinoamérica. Finalmente, me gustaría agradecer a todo el equipo de Laspau por hacerme sentir una integrante más durante esos días, y al doctor Eric Mazur, por sus consejos y por abrirme las puertas a Harvard SEAS.

Además, me gustaría agradecer al doctor Dragan Gasevic — profesor que se ha sumado al comité de evaluación de esta tesis como investigador internacional, y a todos los investigadores que son parte del proyecto LALA—‘*Building Capacity to Use Learning Analytics to Improve Higher Education in Latin America*’, especialmente a Yi-Shan, Margarita, Eliana y Paola por todas aquellas rondas de codificación y todas aquellas discusiones sobre las diferentes necesidades de analíticas de aprendizaje en nuestras instituciones. También me gustaría agradecer a la doctora Mary Ellen Wiltrout, quien me acogió durante mi pasantía en el contexto de un proyecto MISTI-MIT, y a Vanesa Grbic, quien ha sido la paciente y rigurosa editora de diferentes artículos de investigación que he liderado, incluyendo la revisión de diferentes capítulos de esta tesis.

Soy consciente de que muchas personas me han apoyado y acompañado durante mi doctorado, y que no necesariamente han sido mencionados en esta sección de agradecimientos. A esas personas me gustaría decirles que atesoro el apoyo entregado, y que buscaré retribuirlo de alguna manera. También soy consciente de que algunas personas que me han acompañado durante mi camino ya no están necesariamente conmigo, y que no les puedo agradecer ni retribuir el apoyo entregado. Una de esas personas es mi tía Ximena Carrasco, quién falleció a inicios de este año. Fui testigo de su lucha contra el cáncer y de su fe inquebrantable ante difíciles momentos que le tocó vivir producto de esta enfermedad. Es por esto que le dedicó esta tesis a ella como una forma de atesorar su recuerdo y de representar a través de su persona la perseverancia que me permitió convertirme en investigadora.

INDEX

Pp.

LIST OF TABLES

Pp.

LIST OF FIGURES

Pp.

RESUMEN

En las últimas dos décadas, la cobertura de la educación superior creció exponencialmente en Latinoamérica, generándose disparidades en la calidad de sus programas. Esto hace necesario implementar procesos de mejora continua curricular para formular acciones de mejora si los logros de aprendizaje no son los esperados. La reciente aparición de las analíticas de aprendizaje facilita la integración y el análisis de distintos datos educativos con el fin de renovar elementos curriculares. Sin embargo, la disponibilidad y el despliegue de soluciones analíticas no reporta beneficios si su adopción no está estrechamente centrada en las necesidades de los actores clave. En este contexto, esta tesis tiene como objetivo responder a la pregunta de investigación: ¿Cómo promover la mejora continua del currículo en los programas de educación superior en Latinoamérica utilizando Analíticas de Aprendizaje? Para responder a esta pregunta, se utilizaron métodos mixtos dentro de enfoques de investigación tradicionales. Primero, se realizaron entrevistas y cuestionarios para identificar necesidades de analíticas de aprendizaje en estudiantes, profesores, y gestores de distintas universidades. Segundo, se diseñó y evaluó una herramienta analítica para apoyar la formulación de acciones de mejora curricular a partir de la medición de logros de aprendizaje. Tercero, se elaboró un caso de estudio para identificar mecanismos para involucrar a los profesores en medición y mejora de los logros de aprendizajes. A partir de estos tres estudios, se desarrolló un marco para promover la mejora continua curricular en los programas de educación superior en América Latina. El uso de este marco permitirá que las universidades reflexionen sobre los cambios curriculares generados durante la pandemia, formulando acciones de mejora según sus necesidades. Además, esta tesis contribuye con un conjunto de lecciones aprendidas en relación al diseño e implementación de una herramienta de analítica curricular y al involucramiento de profesores en un proceso de mejora continua a lo largo de un extenso período de tiempo.

Palabras Claves: Educación Superior, Analítica de Aprendizajes, Analítica Curricular, Latinoamérica, Calidad Educativa, Métodos Mixtos

ABSTRACT

Latin American universities have an urgent need to improve student learning and program quality. To address these challenges, researchers and practitioners perceive Learning Analytics (LA) as a promising strategy to support continuous curriculum improvement. Furthermore, the recent emergence of curriculum analytics creates the opportunity to integrate and analyse program- and course-level data, in order to renew curriculum strategies based on learning results. However, the availability and deployment of curriculum analytics solutions does not guarantee institutional benefits if its adoption is not closely integrated with curriculum elements. As the interest in LA grows, more studies should explore stakeholders' needs for analytical tools, along with identifying mechanisms that engage teaching staff with outcome assessment tasks and curriculum discussions. This thesis aims to answer the research question: *How to promote continuous curriculum improvement in higher education programs in Latin America using Learning Analytics?* For answering this research question, this thesis uses mixed methods procedures within traditional research approaches. First, a convergent parallel approach of interviews and questionnaires was used to identify LA needs from the perspective of managers, teaching staff, and students. Second, a design-based research approach was used to design and evaluate a curriculum analytics tool to support continuous curriculum improvement in different university settings. Third, a single-case study was used to understand how teaching staff engage with continuous curriculum improvement. As a result of integrating findings from these three studies, a framework was developed to promote continuous curriculum improvement in higher education programs in Latin America, besides proposing a methodological approach that could be applied in other regions to capture the needs of higher education stakeholders during and after the COVID-19 pandemic. Further contribution of this thesis includes a set of lessons learned from having designed, adapted and incorporated a curriculum analytics tool into a continuous improvement process.

Keywords: Higher Education, Learning Analytics, Curriculum Analytics, Latin America, Quality Culture, Mixed-Methods

1. INTRODUCTION

1.1 Background

In Latin America, access to higher education has grown dramatically in the last three decades (Ferreyra et al., 2017; Fischman & Ott, 2018). This rapid growth has not only increased the diversity of students' socioeconomic backgrounds, but also the diversity of higher education institutions and programs (Bernasconi & Celis, 2017; Ferreyra et al., 2017). Although the coverage expansion was crucial to serve a wider and more heterogeneous student population, it has generated major challenges regarding quality and equity. On the one hand, students with high socio-economic status are more likely to gain access to high quality programs (Ferreyra et al., 2017), whose curriculum and teaching practices are more relevant to the acquisition of key knowledge and skills (Dicker et al., 2019). On the other hand, students with low socio-economic status are more likely to drop out than other students (Ferreyra et al., 2017), which means that they are not necessarily exposed to curriculum and teaching practices that favour their retention and timely graduation (Dicker et al., 2019).

In this new landscape, many universities and colleges have seen Learning Analytics (LA) as a promising strategy to support institutional processes (Ferguson et al., 2016); leveraging existing data to monitor students' progress and improve program quality (Cobo & Aguerrebere, 2018). One of these processes is **continuous curriculum improvement**, *which consists of systematically assessing student outcomes in specific courses of an academic program, in order to evaluate the effectiveness of curriculum and teaching practices in terms of learning results* (Harper & Lattuca, 2010; Lattuca & Stark, 2009) . This type of process requires analysis of large amounts of data, such as graduate profile skills, course learning outcomes, course enrolment, course methods, and learning results (M. Brown, DeMonbrun, & Teasley, 2018; Chou et al., 2015; Gottipati & Shankararaman, 2017). The recent emergence of **curriculum analytics** tools creates the opportunity to integrate and analyse program- and course-level data, and consequently formulate

improvement actions based on evidence of learning results (Pistilli & Heileman, 2017).

Over the past few years, continuous curriculum improvement has become crucial to create a shared culture of quality in higher education; encouraging staff to introduce curriculum and teaching practices that are relevant in terms of student learning (Dicker et al., 2019; Riad Shams & Belyaeva, 2019). However, teaching staff perceive that they have not been adequately consulted by managers about the learning outcomes their students are expected to achieve (Schoepp & Tezcan-unal, 2017; Vican et al., 2020), so they perceive that they have lost autonomy and influence on how to improve student outcome attainment (Bendermacher et al., 2017; Brady & Bates, 2016). For raising awareness of what high quality education requires from all higher education stakeholders, the European Association for Quality Assurance in Higher Education (formerly the European Network for Quality Assurance — ENQA) defined the term ‘quality culture’ as the idea of continuous curriculum improvement embraced by all: students, teaching staff, and managers (ENQA, 2015; EUA, 2006). With this in mind, Bendermacher, oude Egbrink, Wolfhagen, and Dolmans (2017) conducted a realistic review to untangle this concept in favour of promoting a quality culture within higher education institutions. According to these authors, an academic program that intends to systematically enhance quality is not only characterized by structure/organizational processes to coordinate individual efforts for continuous improvement, but also cultural/physiological mechanisms to create shared meaning, expectations and commitment towards the improvement of the quality of teaching and learning.

In view of the urgent need to create a quality culture in Latin American universities (Cobo & Aguerrebere, 2018; Ferreyra et al., 2017), new mechanisms are required to create shared understanding of continuous curriculum improvement among its stakeholders (Matthews & Mercer-Mapstone, 2018; Roberts, 2015). Considering the amount of educational data that these institutions have accumulated in the last two decades, Latin American universities would be able to design and implement LA tools to support the curriculum renewal strategies that are needed to improve program

quality and foster student persistence (Cobo & Aguerrebere, 2018; Viberg et al., 2018).

This thesis addresses this need in higher education systems in Latin America and other developing regions, presenting a series of studies on how to promote continuous curriculum improvement using LA tools. These studies were developed within a large-scale capacity-building project to design and implement LA tools in Latin America (LALA project- https://www.lalaproject.org/), aiming to improve the quality of higher education in this region.

1.2 Scope and research questions

This thesis answers the following research question: *How to promote continuous curriculum improvement in higher education programs in Latin America using Learning Analytics?* Specifically, this thesis proposes a framework for higher education institutions in Latin America, engaging stakeholders in the development of LA tools to support continuous curriculum improvement.

To the best of our knowledge, a framework of this nature has not yet been established for developing regions. Even in developed regions, where researchers have made more progress in the design and implementation of LA services — such as Europe, North America, and Australia — there is limited evidence regarding the institutional adoption of LA to improve learning results and program quality (Gašević et al., 2017; Viberg et al., 2018). As the interest in LA grows in Latin America, more studies should explore the needs of LA in higher education institutions, identifying the perspectives of different stakeholders regarding how these tools could be used to improve student learning and program quality in this region. Thus, the scope of this thesis covers current literature on the adoption of LA, expanding the existing knowledge on curriculum analytics.

Curriculum analytics emerged as a subfield of LA, aiming to leverage the potential of LA tools to support curriculum decision-making and program improvement (Greer, Molinaro, et al., 2016). Based on prior research of Ochoa (2016), we define **curriculum analytics** as *the collection, analysis, and visualization of program- and course-level data, such as program structure and course grading, to inform*

curriculum renewal strategies at an institutional level. So far, some promising tools have been developed to identify courses where the improvement of learning results is crucial for program quality (Pistilli & Heileman, 2017). However, little is known about how these tools support institutional processes for continuous curriculum improvement in existing university settings (M. Brown et al., 2018).

As a consequence, most managers and teachers still lack systematic information to monitor student outcome attainment (Bouwma-Gearhart & Hora, 2016; Chou et al., 2015). Moreover, most teaching staff members do not yet have curriculum analytics tools to collect and analyse data (Bouwma-Gearhart & Hora, 2016), which limits their capacity to reflect on how to improve curriculum and teaching practices (Barradell et al., 2017). This partly explains why teaching staff rarely engage with curriculum theory and practice, so they are not necessarily assessing student learning in a meaningful way (Matthews & Mercer-Mapstone, 2018).

Besides, managers have implemented centralized processes to respond to external demands of evidence of student outcome attainment, such as the ones required by national and international accreditation agencies (Shay, 2016; Swarat et al., 2017). Subsequently, teaching staff perceive curriculum decision-making as increasingly centralized, feeling that managers go as far as to make decisions that affect curriculum elements — such as instructional resources, teaching activities, and assessment methods — without considering their input. (Vican et al., 2020). Thus, most teaching staff conceive continuous curriculum improvement as an administrative or managerial process (Bendermacher et al., 2017; Brady & Bates, 2016), regardless of its relevance to the analysis of the quality of teaching and learning at a program-level (Matthews & Mercer-Mapstone, 2018).

To address these gaps in the literature, and contribute to the Latin American region with new curriculum analytics solutions, this thesis addresses the following research problems:

- **Research problem 1 (RP1):** There is a lack of studies about stakeholders' needs of LA in higher education institutions, hindering the design, implementation and adoption of LA tools that could be used to address challenges of quality and equity in Latin America.

- **Research problem 2 (RP2):** There is a lack of curriculum analytics tools to monitor student learning, not having program- and course-level data to support continuous curriculum improvement in existing university settings.
- **Research problem 3 (RP3):** There is a lack of faculty engagement in continuous curriculum improvement, regardless of its relevance to the analysis of the quality of teaching and learning at a program-level.

Along with the research problems previously formulated, this thesis addresses the following three research sub-questions:

- **Research sub-question 1 (RQ1):** What are the needs for LA adoption in Latin American universities from the perspective of their stakeholders (students, teaching staff, and managers)?
- **Research sub-question 2 (RQ2):** How does a curriculum analytics tool impact continuous curriculum improvement in higher education settings?
- **Research sub-question 3 (RQ3):** How do mechanisms engage and disengage teaching staff in a higher education institution with continuous curriculum improvement?

1.3 Research objectives

The general objective of this thesis is: *to establish a framework for promoting continuous curriculum improvement in higher education programs in Latin America, using learning analytics solutions centred on the needs of managers, teaching staff, and students*. This general objective is divided into three specific objectives:

- **Research objective 1 (RO1):** To identify stakeholders' needs for LA that affect the continuous improvement of higher education programs in Latin America from the perspective of their managers, teachers, and students.
- **Research objective 2 (RO2):** To design, implement and evaluate a curriculum analytics tool to support continuous curriculum improvement of higher education programs in Latin America.

- **Research objective 3 (RO3):** To understand how to engage teaching staff in continuous curriculum improvement of higher education programs in Latin America.

1.4 Methodology

This thesis was conducted under a protocol approved by the Ethics Committee of the Pontificia Universidad Católica de Chile (protocol identifier number 180325003), in accordance with the ethical standards of all the institutions participating in each study. The methodology established in this protocol follows a mixed methods approach. By mixed methods, Creswell (2012) refers to the procedure of collecting, analysing, and integrating both quantitative and qualitative research methods in a single study or a series of studies to understand a research problem. According to Creswell (2010), the nature of mixed methods can be expanded to include different applications, integrating its procedures into existing research designs. Along these lines, this thesis used mixed methods procedures within traditional research approaches, such as a convergent parallel design, a design-based research approach, and a case study design. Each one of these research approaches is used to answer a specific sub-question (see research sub-questions in section 1.3).

First, **as to identify stakeholders' needs for LA** (RO1), we adopted a **convergent parallel design** that complements qualitative information obtained from a small sample with quantitative results obtained from a larger number of individuals. This type of research design consists of simultaneously collecting both qualitative and quantitative data, analysing both datasets separately, comparing results, and making an interpretation as to whether the results support or contradict each other (Creswell, 2012). In this thesis, we decided to adapt materials produced by the SHEILA project to the Latin American context (accessible at https://sheilaproject.eu/sheila-framework/), in order to collect information regarding stakeholders' perceptions related to LA adoption in the four Latin American universities affiliated to the LALA project. As a result of adapting these materials, we collected qualitative data by means of semi-structured interviews with 37 senior managers, and 16 focus groups with 51 teaching staff and 45 students, respectively. We also collected quantitative

data by conducting a student survey and a staff survey, which attracted responses from 1,884 students and 368 teaching staff members.

Second, **as to design, implement, and evaluate a curriculum analytics tool** (RO2) we followed a **design-based research** approach. Specifically, we used the phases of the Integrative Learning Design (ILD) Framework to develop a curriculum analytics tool, and to evaluate its use and usefulness in a two-cycle structure (Bannan-Ritland, 2003). The first cycle consisted of an enactment phase to develop a first version of the tool, followed by an instrumental case study to evaluate its use to support 124 teaching staff members in a 3-year continuous improvement process at a Latin American university. The second cycle consisted of an enactment phase to redesign the tool, followed by workshops to evaluate its perceived usefulness with 16 managers and 9 teaching staff members in two Latin American universities. Throughout the two cycles, we used different data gathering techniques to collect qualitative and quantitative information, such as document analysis and questionnaires.

Third, **as to understand how to engage teaching staff in continuous curriculum improvement** (RO3), we used **single-case study** design. According to Yin (2014), single-case studies are useful to investigate a contemporary phenomenon in a real-world setting from a longitudinal perspective, allowing researchers to explore how this phenomenon changes over time. In this thesis, a single-case study is used to understand how faculty engage or disengage with a continuous improvement process implemented between 2015 and 2017 in a Latin American university. To develop this case study, we triangulated quantitative and qualitative information obtained from three sources of evidence: 97 assessment plans, 27 meeting minutes, and 11 interviews with teaching staff. Then, the case study analysis consisted of contrasting evidence obtained from these different sources to deepen our understanding of mechanisms that engaged and disengaged teaching staff from continuous improvement tasks.

In all the studies previously described, data collection involved the use of informed consent forms to conduct interviews, focus groups, and questionnaires. Besides, identifiable data was removed from sources of qualitative and quantitative

information, such as audio files and spreadsheets. From those data sources, we extracted findings to answer each one of the research questions linked to the research objectives addressed in this thesis. Besides, we integrated all findings to meet the general research objective, which is *to establish a framework for promoting continuous curriculum improvement in higher education programs in Latin America, using LA solutions centred on the needs of managers, teaching staff, and students* (see Figure 1-1).

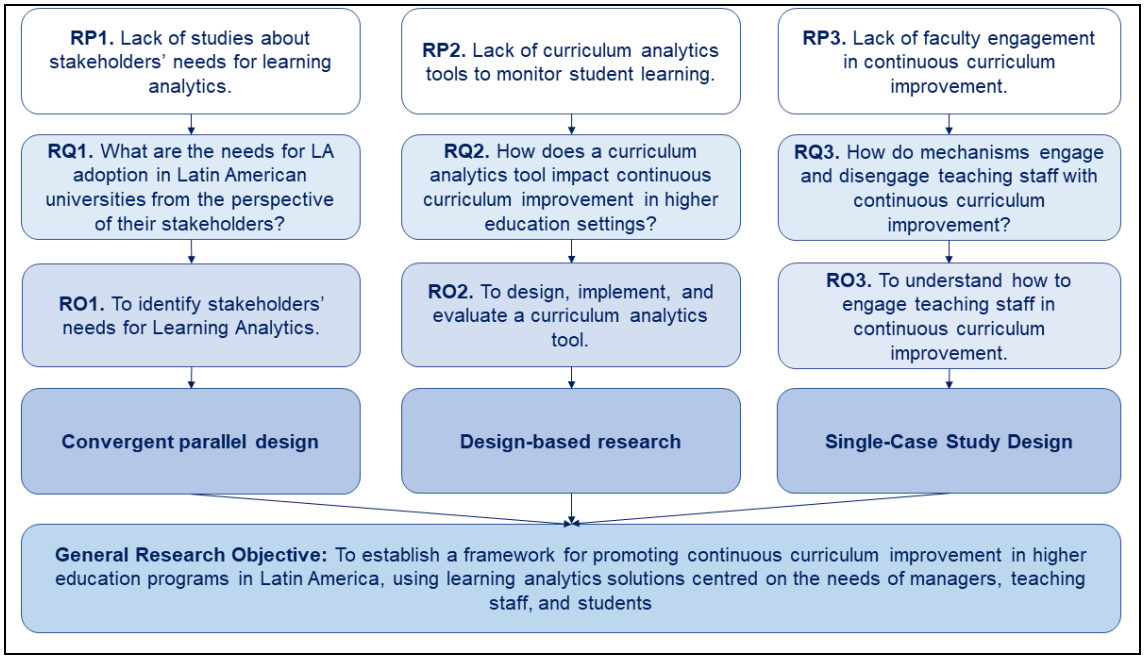

Figure 1-1: Methodological approach used to meet general and specific research objectives.

1.5 Contributions

This thesis contributes to expanding the existing body of knowledge by means of scientific publications and implications for higher education practice. Table 1-1 presents the 12 academic contributions of this thesis, including five indexed in the ISI Web of Science, one book chapter, and six conference proceedings.

Specifically, this thesis contributes with:

1. **An in-depth analysis of the needs for LA Adoption in Latin American universities from the perspective of managers, teaching staff, and students therein.** On the one hand, publications 1 and 2 present empirical evidence about educational challenges faced by internal stakeholders in four Latin American universities, in addition to describing existing LA solutions that could help address these challenges. On the other hand, publication 3 describes data-related practices that could benefit from integrating LA services, in addition to revealing the need to develop policies to guide the adoption of LA in Latin American contexts.
2. **A set of lessons learned from having designed, adapted, and implemented LA tools in different Latin American universities; including a curriculum analytics tool to support institutional processes for continuous curriculum improvement**. Publications 4-7 describe these lessons learned, including guidelines to design and adapt LA tools, to engage stakeholders throughout their implementation, and to develop policies of scaling up their adoption at an institutional level. Concerning curriculum analytics, publications 8-10 delve deeper into the design and implementation of a curriculum analytics tool, describing a design-based research approach to evaluate its use and its perceived usefulness to drive curriculum decision-making and program improvement.
3. **A case study to illustrate how teaching staff engage with continuous improvement processes to inform the renewal of curriculum and teaching practices.** Publications 11 and 12 present a case study about a 3-year continuous improvement process that was implemented at an engineering school in a large and selective university in Chile. The findings of this case study describe mechanisms that engage and disengage teaching staff with continuous improvement tasks, such as outcome assessment and curriculum decision-making. Besides, teaching staff's perspectives on continuous curriculum improvement were discussed for further generalization of these mechanisms for other university settings.

4. **A framework to promote the implementation of continuous curriculum improvement in higher education programs using learning analytics**. Based on the findings of the publications developed throughout this thesis, practical suggestions were extrapolated to promote continuous curriculum improvement in higher education programs in Latin America and other developing regions. These suggestions were integrated into a framework for higher education institutions, providing a basic structure to guide needs assessment, tool development, and process implementation. Further details of this framework are presented in the final chapter, along with future work derived from this thesis.

Table 1-1: Summary of academic contributions of this thesis

	Reference	**Type of publication**	**Status**
1	**Hilliger, I.**, Ortiz-Rojas, M., Pesántez-Cabrera, P., Scheihing, E., Tsai, Y. S., Muñoz-Merino, P. J., ... & Pérez-Sanagustín, M. (2020). Identifying needs for learning analytics adoption in Latin American universities: A mixed-methods approach. *The Internet and Higher Education*, *45*, 100726.https://doi.org/10.1016/j.iheduc.2020.100726	Journal Article (Impact Factor: 5.284)	Published
2	**Hilliger, I.**, Pérez-Sanagustín, M., Ortíz, M., Pesántez, P., Scheihing, E., Tsai, Y. S., ... & Broos, T. (2019). Assessing institutional needs for learning analytics adoption in Latin American higher education. *Scalability and Sustainability of Learning Analytics Solutions* (SASLAS19).	Conference Proceedings	Published
3	**Hilliger, I.**, Ortiz-Rojas, M., Pesántez-Cabrera, P., Scheihing, E., Tsai, Y. S., Muñoz-Merino, P. J., ... & Pérez-Sanagustín, M. (2020). Towards learning analytics adoption: A mixed methods study of data-related practices and policies in Latin American universities. *British Journal of Educational Technology*. https://doi.org/10.1111/bjet.12933	Journal Article (Impact Factor: 2.588)	Published
4	Broos, T., **Hilliger, I.**, Pérez-Sanagustín, M., Htun, N. N., Millecamp, M., Pesántez-Cabrera, P., ... & De Laet, T. (2020). Coordinating learning analytics policymaking and implementation at scale. *British Journal of Educational Technology*. https://doi.org/10.1111/bjet.12934	Journal Article (Impact Factor: 2.588)	Published

	Reference	Type of publication	Status
5	**Hilliger**, **I.**, Pérez-Sanagustín, M., Pérez-Álvarez, R., Henríquez, V. Guerra, J., Zuñiga, M. A., Ortiz-Rojas, M. Tsai, Gasevic, D., Muñoz-Merino, P. J., Broos, T., & De Laet, T. (2020). Leadership and Maturity: How Do They Affect Learning Analytics Adoption in Latin America? In Ifenthaler, D. & Gibson, D. (Eds.), *Adoption of Data Analytics in Higher Education Learning and Teaching*. Switzerland AG: Springer Nature	Book Chapter	Accepted (In Press)
6	Ortiz-Rojas, M., Maya, R., Jimenez, A., **Hilliger, I.,** & Chiluiza, K. (2019, October). A step by step methodology for software design of a learning analytics tool in Latin America: A case study in Ecuador. In 2019 XIV Latin American Conference on Learning Technologies (LACLO) (pp. 116-122). IEEE. https://doi.org/10.1109/LACLO49268.2019.00029	Conference Proceedings	Published
7	Maldonado-Mahauad, J., **Hilliger, I.**, De Laet, T., Millecamp, M., Verbert, K., Ochoa, X., & Pérez-Sanagustín, M. (2018, March). The LALA project: Building capacity to use learning analytics to improve higher education in Latin America. In companion proceedings of the 8th international learning analytics & knowledge conference (pp. 630-637).	Conference Proceedings	Published
8	**Hilliger, I.**, Miranda, C., Celis, S., & Pérez-SanAgustín, M. (2019). Evaluating Usage of an Analytics Tool to Support Continuous Curriculum Improvement. In EC-TEL (Practitioner Proceedings). http://ceur-ws.org/Vol-2437/paper5.pdf	Conference Proceedings	Published
9	**Hilliger**, **I.**, Aguirre, C., Miranda, C., Celis, S. & Pérez-Sanagustín, M. (2020) Design of a curriculum analytics tool to support continuous improvement processes in higher education, in Proc. of the *Tenth International Conference on Learning Analytics & Knowledge* (LAK'19), pp. 181-186 https://doi.org/10.1145/3375462.3375489	Conference Proceedings	Published
10	**Hilliger, I.**, Aguirre, C., Miranda, C., Celis, S. & Pérez-Sanagustín, M. (2020) Design-based Research for Developing a Curriculum Analytics Tool for Improving Student Learning and Program Quality. *Journal of Learning Analytics*.	Journal Article (recently indexed)	Sent
11	**Hilliger, I.,** & Celis, S., & Pérez-Sanagustín, M. (2020). Engaged Versus Disengaged Teaching Staff: A Case Study of Continuous Curriculum Improvement in Higher Education. Higher Education Policy. https://rdcu.be/b4vDf	Journal Article (Impact Factor: 1.333)	Published
12	**Hilliger, I.**, & Celis, S., & Pérez-Sanagustín, M., & Baier, J. (2019, June), Work in Progress: Engaging Engineering Teaching Staff in Continuous Improvement Process Paper presented at 2019 *ASEE Annual Conference & Exposition*, Tampa, Florida. https://peer.asee.org/33612	Conference Proceedings	Published

1.6 Structure

This thesis is structured into five main chapters. Table 1-2 describes these five chapters, their objective, and their relationship with academic contributions when applicable. Along with the thesis introduction described in this chapter, Chapters 2, 3, and 4 present the main findings obtained from applying mixed methods approaches to meet each one of the research objectives described in section 1.3.

Table 1-2: Relationship among thesis chapters, research objectives and academic contributions

Thesis chapter	Chapter objective	Academic contributions
1	Presenting the thesis background, scope, methodology, academic contributions, and structure.	Not applicable
2	**Addressing research objective 1:** To identify LA needs that affect the continuous improvement of higher education programs in Latin America from the perspective of their managers, teachers, and students.	See publication 1 in Table 1-1 (in addition to publications 2-7)
3	**Addressing research objective 2:** To design and evaluate a curriculum analytics tool to support continuous curricular improvement of higher education programs in Latin America.	See publication 10 in Table 1-1 (in addition to publications 8 and 9)
4	**Addressing research objective 3:** To understand how to engage teaching staff in a higher education institution in Latin America in a process of continuous curriculum improvement.	See publication 11 in Table 1-1 (in addition to publication 12)
5	Presenting the thesis conclusions, implications for practice, and derived future work.	Not applicable

Chapter 2 presents the convergent parallel approach used to identify LA needs that affect the continuous improvement of higher education programs in Latin America. This chapter includes a literature review on current challenges in higher education in Latin America, followed by an analysis of the needs for LA tools and methods to address these challenges. Then, this Chapter illustrates how mixed methods were used to identify needs for LA adoption in four Latin

American universities, besides reporting the findings obtained from triangulating qualitative and quantitative information collected from students, teaching staff, and managers. Based on these findings, we discuss considerations and recommendations for LA adoption in the Latin American region.

Chapter 3 presents the design-based research conducted to design and evaluate a curriculum analytics tool to support continuous curriculum improvement in different university settings. This chapter includes a literature review about the emergence of the curriculum analytics field, followed by an analysis of existing curriculum analytics tools. Then, this Chapter describes the different phases of the ILD framework that were used in the two-cycle structure to develop a curriculum analytics tool and evaluate its use and its usefulness in different university settings. First, we present the informed exploration phase and its findings. This phase leads to the description of the first and the second cycle. Finally, the chapter presents a broad evaluation phase to document lessons learned from both cycles, in addition to discussing the implications for other higher education institutions.

Chapter 4 presents the case study conducted to illustrate engagement and disengagement mechanisms regarding continuous improvement tasks. This chapter includes a literature review about teaching staff engagement and disengagement with continuous curriculum improvement. Then, this Chapter illustrates how the case study was developed, besides describing the case study context and proposition. Finally, the chapter presents the predominant mechanisms that were identified from the case study analysis, and practical implications to promote continuous curriculum improvement from teaching staff's perfectives.

Chapter 5 presents a summary of the main contributions of this dissertation. For further generalization of the thesis findings, this chapter also includes a section about implications for practice. This section describes the framework proposed to promote continuous improvement in higher education institutions in Latin America, taking advantage of learning analytics tool to improve student learning

and program quality. Finally, this Chapter describes future work derived from this thesis.

This thesis also includes a glossary of concepts to standardize and rationalize the specific terminology used in the thesis, in addition to appendices that contain the protocols used throughout the thesis to collect data and answer each research question (see Appendices A-E).

2. IDENTIFYING NEEDS FOR LEARNING ANALYTICS IN LATIN AMERICAN HIGHER EDUCATION

This chapter presents the mixed convergent parallel approach used to meet **research objective 1 (RO1 in Figure 1-1)**: *to identify LA needs that affect the continuous improvement of higher education programs in Latin America from the perspective of their managers, teachers and students*. First, this chapter provides a literature review on current challenges in higher education systems in Latin America, followed by an analysis of the needs for LA tools and methods to address challenges. Then, the chapter describes the findings that answer **research sub-question 1 (RQ1 in Figure 1-1)**: *What are the needs for LA adoption in Latin American universities from the perspective of its stakeholders (students, teaching staff, and managers)?* These findings are based in the triangulation from qualitative and quantitative information, revealing five stakeholders' needs for educational data analysis to improve student learning and program quality. Finally, this chapter discusses how existing LA solutions could meet these needs, besides identifying data protection policies that need to be in place before incorporating LA services.

2.1. Literature review

2.1.1. Current challenges of higher education in Latin America

In Latin America, higher education has experienced deep transformations over the past decades. At the onset of the 1980s, further reforms started to expand higher education enrolment in Chile and other countries, along with creating new higher education institutions and programs (Bernasconi & Celis, 2017; Ferreyra et al., 2017). As a consequence, college access grew dramatically in the early 2,000s, promising further knowledge production and inclusion of students from middle and low-income backgrounds (Ferreyra et al., 2017). Today, the gross enrolment rate is 51% in higher education in the region (UNESCO-IESALC, 2019), and about 10,000 institutions and 60,000 programs serve more than 20 million students (Ferreyra et al., 2017). However, the desired effects have not been fully produced, mainly because of program quality disparities. In order to reduce these disparities, Latin American

governments started implementing quality assurance policies to reinforce minimum input requirements — such as faculty qualifications, curricula criteria, and infrastructure regulations (Bernasconi & Celis, 2017; Ferreyra et al., 2017). One of the most widely studied policies has been the quality assurance system implemented in Chile in 2006 (Cancino & Schmal, 2014; OECD, 2012). As a consequence of this policy, most Chilean universities had voluntarily undergone an accreditation process by 2010, but the number of years and accredited programs for each institution confirmed the broad quality disparities instead of reducing them (Cancino & Schmal, 2014; OECD, 2012). That same year, Ecuador implemented a new higher education law to define quality regulations for existing and emerging institutions (Edenfield, 2016; Johnson, 2017), in addition to making public universities tuition-free. Although more research is needed to understand how Ecuadorian universities are coping with this new law (Johnson, 2017), studies already reveal that quality problems have not been fully resolved in this or any other country in the region (Edenfield, 2016; Ferreyra et al., 2017).

Therefore, the deployment of governmental reforms has not solved the challenges generated by enrolment expansion in Latin America (Bernasconi & Celis, 2017; Knobel & Bernasconi, 2017). Youth from the top income quintile are more likely to gain access to high quality education, while youth from the bottom quintile are less likely to graduate (Ferreyra et al., 2017). These disparities between students from different socioeconomic backgrounds have raised public concern to this day, considering that low-income students are still the ones at higher risk of dropping out and being disfavoured by disparities in lifetime earnings (González-Velosa et al., 2015). Furthermore, these disparities have led to student movements in Chile, Colombia and Mexico in 2011 (Bernasconi & Celis, 2017), and recent budget cuts and austerity measures have also led to student protests in Ecuador, Argentina, and Colombia (Telesur, 2018).

In this context, higher education in Latin America has the urgent need to solve disparities in program quality, reduce dropout rates, and bridge the gaps in existing regulatory policies (Cobo & Aguerrebere, 2018; Ferreyra et al., 2017). From current practice in the UK and other developed countries, researchers have argued that LA

services could become a valuable strategy to tackle issues related to these problems, such as providing personalized feedback and support to an increasing number of learners (Cobo & Aguerrebere, 2018; Gašević, 2018). However, the availability and deployment of LA tools does not guarantee institutional benefits if their adoption does not meet stakeholders' needs for information in their everyday practice (Ferguson et al., 2016; Viberg et al., 2018). Thus, this chapter documents the steps undertaken to achieve research objective 1, aiming to identify the needs of stakeholders in Latin American universities as a starting point for using LA services to improve program quality and student learning.

2.1.2. Needs for LA adoption

Although Latin American universities could implement LA services to tackle persisting quality disparities among higher education programs (Cobo & Aguerrebere, 2018; Gašević, 2018), current evidence of the impacts of LA on the transformation of higher education institutions is yet to be observed (Gašević et al., 2017; Viberg et al., 2018). Most studies have concentrated on the design and implementation of LA tools and methods to monitor learning outcomes (Ferguson et al., 2016; Ifenthaler, 2017), while few of them have analysed how stakeholders may benefit from adopting those tools and methods in their everyday practice (Ferguson et al., 2016; Viberg et al., 2018).

In recent years, some studies have proposed the use of dashboards about students' learning characteristics and patterns (Bodily & Verbert, 2017; Jivet et al., 2018), in order to make learning experiences more personal and engaging (Ifenthaler, 2017; B. T. M. Wong, 2017). Researchers argue that these dashboards provide students with insightful data to reflect on their learning results, besides allowing teaching staff to identify students that might be at risk (Bodily & Verbert, 2017; B. T. M. Wong, 2017). Thus, timely support interventions are expected from the implementation of these type of tools, in order to improve course completion and retention rates (Avella et al., 2016; Sclater et al., 2016). Still, most studies have focused on evaluating dashboards' usefulness and ease of use as perceived by its users, rather than its benefits to the teaching and learning process (Avella et al., 2016; Jivet et al., 2018).

Other LA tools have been proposed to support academic planning and curriculum decision-making from the perspective of different higher education stakeholders (Greer, Molinaro, et al., 2016; Pistilli & Heileman, 2017). Some of these tools provide managers and teaching staff with curriculum mapping visualizations to improve scaffolding of instructional resources and assessment methods (M. Brown et al., 2018; Ifenthaler, 2017; Pistilli & Heileman, 2017), while others provide students with individual visualizations of their academic performance and their competency attainment (Chou et al., 2015; Pistilli & Heileman, 2017).

However, there is limited evidence to anticipate the potential benefits and the foreseen costs of using LA services to improve higher education practices (Ferguson et al., 2016; Viberg et al., 2018). Moreover, a smaller number of studies have addressed the ethical challenges of using these services in an institutional context (Viberg et al., 2018), despite the efforts in this field to acknowledge the importance of ensuring privacy and informed consent in the deployment of analytical tools and methods (Drachsler & Greller, 2016). Consequently, more empirical evidence is required to understand the needs and challenges of using LA tools to support teaching and learning processes from the perspective of students, teaching staff, and managers. Along these lines, the following section presents the study design adopted to collect and analyse empirical evidence regarding the perspectives of these stakeholders on potential needs for LA services in Latin American universities.

2.2. Study design and objective

This study addresses the following research sub-question **(RQ1)**: *What are the needs for LA adoption in Latin American universities from the perspective of their stakeholders (students, teaching staff, and managers)?* To answer this research question, we adopted a mixed convergent-parallel approach to complement qualitative information from a small sample with quantitative results obtained from a larger number of individuals (Creswell, 2012). In order to build upon existing work for collecting stakeholders' perceptions related to LA adoption, we decided to adapt the materials produced by the SHEILA project to the Latin American context (accessible at https://sheilaproject.eu/sheila-framework/). Specifically, we adapted

the focus groups and interview protocols to collect qualitative data, and the student and staff survey protocols to collect quantitative data. Then, we triangulated the results of the qualitative and quantitative data analysis to deepen our understanding of the needs for LA services in this context. This process consisted of contrasting evidence obtained from the different stakeholders that participated in this study (students, teaching staff and managers), and from the different sources of data (focus groups, interviews, and surveys) (Creswell, 2012). Further details about the adaptation of SHEILA protocols is detailed in the data gathering techniques sections.

2.3. Participants and sample

Four universities participated in this study: two traditional private institutions in Chile (U1 and U2), and two public institutions in Ecuador (U3 and U4) (see further details about the four institutions via the link: http://bit.ly/2OpB2va). Not only do these universities differ in size, type of administration, and year of foundation, but they also represent contrasting higher education systems. The Chilean system has been carefully observed and mirrored by other Latin American governments (Torres & Schugurensky, 2002), whereas, the Ecuadorian system has received little attention from researchers and governmental agents from other Latin American countries (Jameson, 1997; Johnson, 2017).

In these two contrasting contexts, we obtained qualitative data from 45 students, 51 teachers, and 37 managers (see Table 2-1). A stratified sampling method was followed to identify students and teaching staff from different academic units, while a snowball sampling method was followed to identify suitable managers to contact until obtaining redundant information (Creswell, 2012). In this study, redundant information was reached when repetitive ideas were collected about potential needs for LA services from an administrative perspective.

Table 2-1: Samples of participants in focus groups and semi-structured interviews

	U1	U2	U3	U4
Focus groups (FG) with students	2 FG (13 students)	1 FG (5 students)	2 FG (3 students)	3 FG (24 students)
Focus groups (FG) with teaching staff	1 FG (5 teachers)	2 FG (15 teachers)	2 FG (8 teachers)	3 FG (23 teachers)
Interviews with managers	7 managers	11 managers	8 managers	11 managers

Additionally, we collected quantitative data from 1,884 students and 368 teaching staff by using online surveys (see Table 2-2). In student survey responses, the representation of undergraduates ranged between 85% and 95%, which is consistent with the universities' current enrolment. In staff survey responses, the percentage of respondents who had eight or more years of teaching experience ranged between 34% and 67%, despite the fact that assistant professors were overrepresented compared to universities' faculty statistics.

Table 2-2: Samples of participants in student and teaching staff surveys

	U1	U2	U3	U4
Number of students enrolled	32,445	16,670	11,922	17,495
Number of students surveyed	878	228	205	573
Number of teaching staff members	1,265	753	960	1,158
Number of teaching staff surveyed	124	79	25	140

Note: The number of students enrolled and staff members per university was retrieved in August, 2019, while student and staff surveys were applied between January and May, 2018. The data obtained from each university was combined into one data set per stakeholder, having a total number of 1,883 and 368 responses for the student and staff survey respectively.

2.4. Data gathering techniques and analysis

2.4.1. Qualitative data collection and analysis

To collect qualitative information, we adapted the SHEILA protocols by revising their Spanish version. First, we had to change the term 'Learning Analytics' for 'educational data analysis' because the LA concept is not widely known in Latin American universities. Second, we had to rephrase all questions about feedback and

interventions based on LA services. We had to include expressions such as ‘data-based feedback’ and ‘data-based actions’, besides adding questions about ‘academic uses of data’. Third, we had to remove all questions about existing LA projects and strategies due to the limited availability of LA services and research experiences at each university. This implied modifying most of the protocol questions for managers and removing the questions about educational support in the staff survey protocol. Finally, we had to include some words and expressions that are commonly used in Chile and Ecuador, in order to make sure that interviewees understood all protocol questions (see English version of the adapted protocol in http://bit.ly/2OjnwJo).

One researcher per university was responsible for conducting the semi-structured interviews and focus groups under the informed consent of the participants. Managers were interviewed individually in 30-minute sessions, whereas teaching staff and students were interviewed in separate focus groups, each one lasting for an hour (see participation and sample in Table 2-1). The audio files obtained from interviews and focus groups were transcribed verbatim. Their analysis was conducted by four researchers, one per university, who summarized interview and focus groups responses into a spreadsheet to develop the first version of a coding scheme. Then, they conducted four rounds of coding practices in NVivo Pro 12, until they obtained moderate to satisfactory Kappa coefficients for all categorical nodes, ranging between 0.55 and 0.99 (McHugh, 2012). In each round, all researchers worked on the same transcript. Throughout the four rounds, they worked with transcripts from the four universities and from the different stakeholders who participated in this study. The final coding was also conducted in NVivo Pro 12, using the coding scheme in the following link: https://bit.ly/311ZtF2. After the final coding practice, a matrix query was obtained to compare the percentage of coding references obtained from students, teaching staff, and managers in different categorical nodes. Although there are divided opinions regarding the quantification of qualitative results, several researchers suggest to use these types of approaches to facilitate pattern recognition and to extract meaning from qualitative findings (Maxwell, 2010; Sandelowski et al., 2009). This is why we adopt this approach in this study, which we complemented with quotes that were extracted and translated to complement this analysis.

2.4.2. Quantitative data collection and analysis

To collect quantitative data, we kept all questions in the SHEILA student and staff survey protocols to avoid changing scales that have been already used in other universities. Still, we did minor language editing to include words and expressions that are commonly used in Chile and Ecuador. We also had to change the expression 'LA services' for 'services based on the analysis of educational data', making sure that the meaning of each survey item stayed the same (see adapted student survey protocol in http://bit.ly/2YGFmsd, and adapted staff survey protocol in http://bit.ly/2CRywXx).

Both student and staff survey protocols consisted of a 7-point Likert scale to measure both ideal and predictive expectations. These two scales were designed to explore expectations and experiences of stakeholders with LA services, in order to solve discrepancies between expectations and actual services (Wainwright et al., 2019). Thus, survey respondents had to report two scores for each item; one for ideal expectations and another one for the predicted expectations. In this study, we only used the scores reported for the ideal expectation scale as a proxy of student and staff preferences regarding LA adoption (the predicted expectation scale was used in publication 3 in Table 1-1). Then, the quantitative analysis consisted in estimating the percentage of respondents who rated a high level of agreement with the statements of the ideal expectations scale in each survey (student scale items: http://bit.ly/2GpZ4RC, staff scale items: http://bit.ly/2K6OdNn). By high-level agreement, we considered respondent scores that were equal to or higher than 6, taking into account that the scale ranged from 1 (strongly disagree) to 7 (strongly agree). We ranked ideal expectation items from the highest to the lowest percentage of respondents who agreed with the corresponding statement, in order to determine the predominant expectations of students and staff concerning LA adoption at their institutions.

2.5. Results

Table 2-3 reports the five main educational needs for LA adoption in Latin American universities. These findings are based on the analysis of the qualitative and quantitative information collected from the three stakeholders. The following subsections were organized to describe the needs of each stakeholder separately.

Table 2-3: Main educational needs for LA adoption according to data triangulation (see supporting data in http://bit.ly/2I6723N)

Findings	Qualitative and quantitative results	Supporting data
1.1. Students need quality feedback and data-driven support from teaching staff to improve their learning results.	- 72% of students' references about their needs for LA services alluded to quality feedback.	Student focus groups (see coding references presented in Figure 2-1)
	- 88% of students survey respondents agreed with the following statement of the ideal expectations scale 'Ideally, the teaching team will be able to provide me with information and support based on the results obtained through the analysis of my educational data.'	Student survey results presented in Figure 2-2 ('teacher feedback' item)
1.2. Students need timely support interventions from staff and managers when they are facing difficulties that affect their academic performance.	- 69% of the coding references obtained from students about managerial needs for LA services alluded to student support.	Student focus groups (see coding references presented in Figure 2-5)
	- 84% of students survey respondents agreed with the following statement of the ideal expectations scale 'Ideally, the teaching staff will have the obligation to support me if the results obtained from the analysis of my educational data show that my performance is below the average, that I am at risk of being suspended (…).'	Student survey results presented in Figure 2-2 ('obligation to act' item)
1.3. Teaching staff need timely alerts from managers to provide better support to students who are facing difficulties that affect their academic performance.	- 70% of the coding references obtained from teaching staff about managerial needs for LA services alluded to student and teacher support (38% and 32% percent respectively).	Staff focus groups (see coding references presented in Figure 2-5)
	- 86% of staff survey respondents agreed with the following statement of the ideal expectations scale 'The university will provide support to the student as soon as possible if the analysis of the student's educational data suggests that he may be having some difficulty or problem.'	Staff survey results presented in Figure 2-3 ('early intervention' item)
1.4. Teaching staff need meaningful and 'easy-to-use' feedback about their performance and the quality of their teaching to inform their practice.	- 43% of staff references obtained about their needs for LA services alluded to performance evaluation, followed by managing student diversity (21%), addressing course planning (20%), and developing teaching skills (16%).	Staff focus groups (see coding references presented in Figure 2-4)
	- 87% of staff survey respondents agreed with the statement 'Ideally, the information provided by the services associated with the use of educational data will be displayed in a comprehensible and easy to read format.'	Staff survey results presented in Figure 2-3 ('feedback format' item)
1.5. Managers need quality information from staff to evaluate support interventions targeted to students.	- 37% of managers' references about their needs for LA services alluded to information to evaluate support interventions, followed by information to improve the allocation of	Interviews with managers (see coding references presented in Figure 2-5)

Findings	Qualitative and quantitative results	Supporting data
	resources (22%).	

Note: Qualitative results were obtained by counting coding references to estimate percentage of coding references in each category, followed by reading the coded content. Quantitative results were obtained by estimating the percentage of survey respondents that agree with the ideal expectations item by dividing the number of respondents who reported scores equal or higher than 6 by the total number of respondents, taking into account that the scale ranged from 1 (strongly disagree) to 7 (strongly agree).

2.5.1 Student' perspectives on needs for LA services

Regarding students' needs, we identified two main findings supported by qualitative and quantitative results. Firstly, students from all institutions pointed out the need for quality feedback and data-driven support from teaching staff to improve their learning results (Finding 1.1 in Table 2-3). On the one hand, qualitative results show that most of the coding references alluded to the need for quality feedback, over enhancing study skills and the learning environment (see Figure 2-1). By quality, students referred to timely and individualized feedback beyond the grading as a form of formative evaluation:

"Sometimes it is frustrating to have a good grade, without receiving feedback. You might have the maximum score, but I feel that there is always something to improve, as well as the feedback beyond the grade." *(Student, U2)*

"I think (feedback) is not effective. In my faculty, every time someone fails, there are few teachers who care if we (students) are all going at the same pace or if someone is stuck. Besides grades, they do not give anything else." *(Student, U4)*

Moreover, data from students' surveys suggest that most students expect their educational data to be used to inform support interventions. The quantitative analysis shows that 88% of student survey responders agreed with the statement 'Ideally, the teaching team will be able to provide me with information and support based on the results obtained through the analysis of my educational data' ('teacher feedback' item of the ideal expectations scale shown in Figure 2-2).

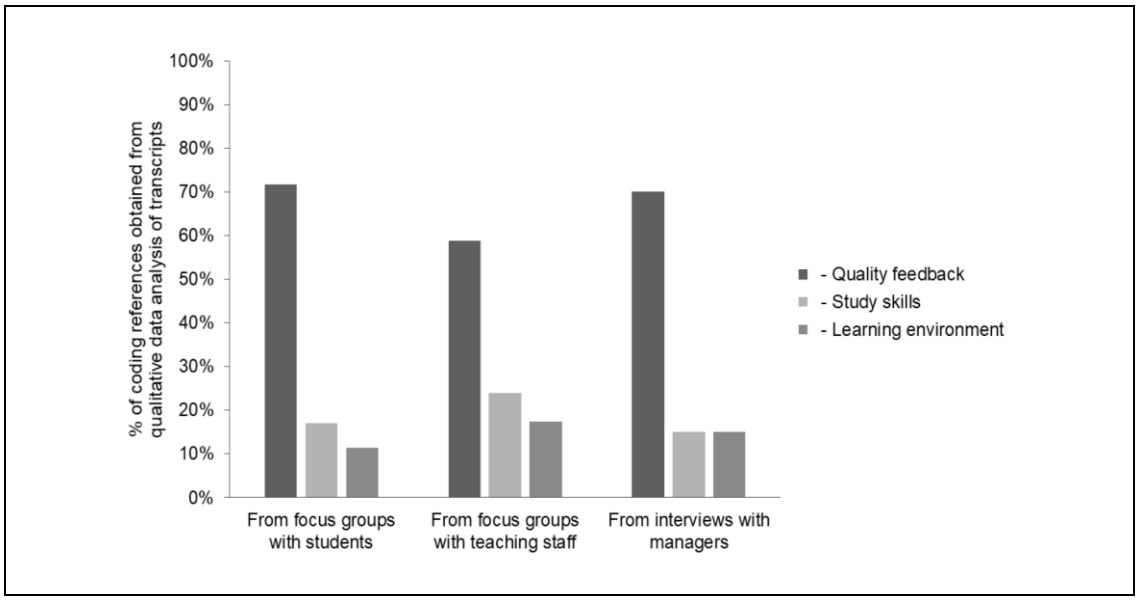

Figure 2-1: Percentage of coding references alluding to students' needs for LA adoption.

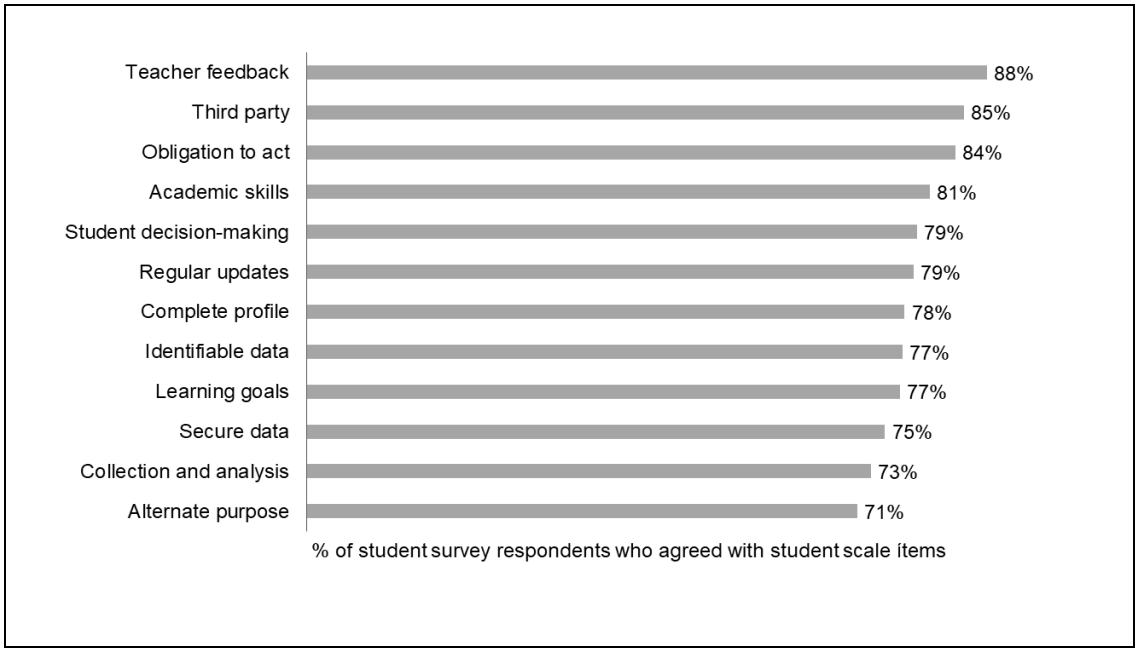

Figure 2-2: Percentage of student survey respondents who agreed with statements that describe ideal expectations for LA adoption (revise student scale items in the following link: http://bit.ly/2GpZ4RC)

Secondly, students need timely support interventions from teachers and managers when they are facing difficulties that affect their academic performance (Finding 1.2

in Table 2-3). On the one hand, qualitative results indicate that students perceive they need more support when they are experiencing social-emotional problems that affect their class attendance. For example, two students from different universities pointed out:

"If you notice that a student is acting weirdly in classes and it's something serious, the professor should notify the department where the psychologists work, so they could call the student – something like that. (…) Likewise, when a student is missing too many classes, they should act on that matter." *(Student, U4)*

"When students are at the risk of an academic dismissal, they give student representatives the information, who are the only person who communicates with these students. If students are officially at the risk of being dismissed, why does the university not communicate with the students?" *(Student, U1)*

On the other hand, data from surveys suggested that students expect their educational data to inform support interventions. Over 80% of students survey respondents agreed with the statement: 'Ideally, the teaching team will have the obligation to support me if the results obtained from the analysis of my educational data show that my performance is below the average, that I am at risk of being suspended (…)' ('obligation to act' item of the ideal expectations scale shown in Figure 2-2).

2.5.2. Teaching staff perspectives on needs for LA services

Regarding teachers' needs, we identified two different findings. The first finding indicates that teaching staff need timely alerts from managers to provide better support to students who are experiencing difficulties (see finding 1.3 in Table 2-3). On the one hand, qualitative data suggests that teaching staff are willing to support students throughout their academic studies, but to do so, they would expect some type of alert or notification from managers when students are facing difficulties:

"I generally teach first-year engineering students, and there were plenty of things that caught my attention. For example, the school of engineering tracks students' performance, they asked me about the grades... and they intervene, they act, they talk to the student, they provide them with support. In my faculty, I was in the curriculum committee for many years and it happened that, suddenly, a student was at risk. I used to think, 'this student was very good when she was with me, what happened? I missed … a more institutional follow-up process." *(Teaching staff member, U1)*

"We have been working with the learning support unit to improve tutoring (…) We have evaluated the students' experience with the psychological services, because the students' self-esteem is one of the things most affected by failing a subject. Then, it is vital to give students psychological support as a positive reinforcement. This has more to do with the emotional wellbeing, rather than tutoring, and it ends up being more of support in the academic area." *(Teaching staff member, U2)*

On the other hand, most of the teaching staff feel that they have the obligation to use educational data to support their students if they are not performing as expected. This is supported by data from the staff surveys, in which 86% of respondents agreed with the statement, 'The university will provide support to the student as soon as possible if the analysis of the student's educational data suggests that he may be having some difficulty or problem.' ('early intervention' item of the ideal expectations scale shown in Figure 2-3).

The second findings about teaching staff indicates that they need meaningful performance evaluation of the quality of their teaching (see Finding 1.4 in Table 2-3). Qualitative results show that most of the coding references obtained from teaching staff alluded to their need for performance evaluations (Figure 2-4). During focus groups, teaching staff claimed they need meaningful information about their teaching practice, beyond such surveys as students' evaluations of teaching:

"I think the teacher survey could inform teaching, but the collective image is like… it does not influence teachers, it does not change your teaching, it does not change the promotion, it does not change anything, so why do you bother? It does not matter, teaching stays the same, the question is: What for? Does it make any sense?" *(Teaching staff member, U1)*

"I believe student performance is also an indicator (of the quality of teaching). If no one participates in class, it would be very strange that it is because of the students rather than the teachers. Personally, I think that you care when a group of students does not excel according to their grade or course performance (…) Maybe that shows us where we are failing, then that could be an indicator." *(Teaching staff member, U4)*

Besides, quantitative results in Figure 2-3 show most teaching staff perceived that the quality of information obtained from the analysis of educational data relies on how easy it is to use for taking actions. Similarly, 87% of staff survey respondents agreed with the statement, 'Ideally, the information provided by the services associated with the use of educational data will be displayed in a comprehensible and easy to read

format' ('format feedback' item of the ideal expectations scale shown in Figure 2-3). In other words, teachers demand actionable information in the form of "easy-to-use" feedback.

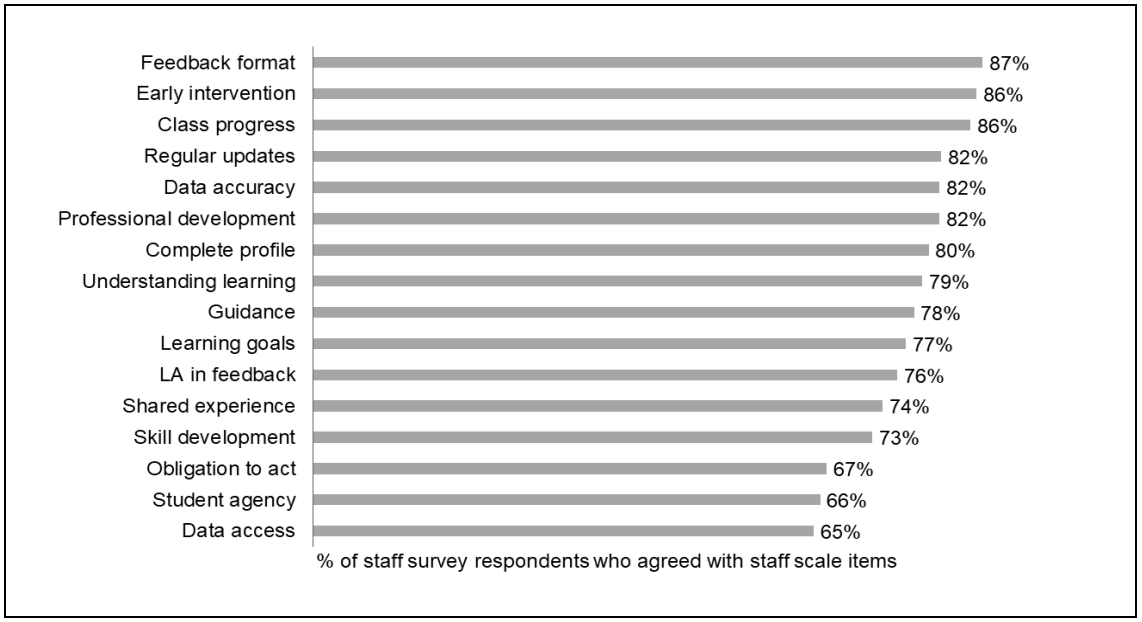

Figure 2-3: Percentage of staff survey respondents who agreed with items that describe ideal expectations for LA adoption (revise staff scale items in the following link: http://bit.ly/2K6OdNn)

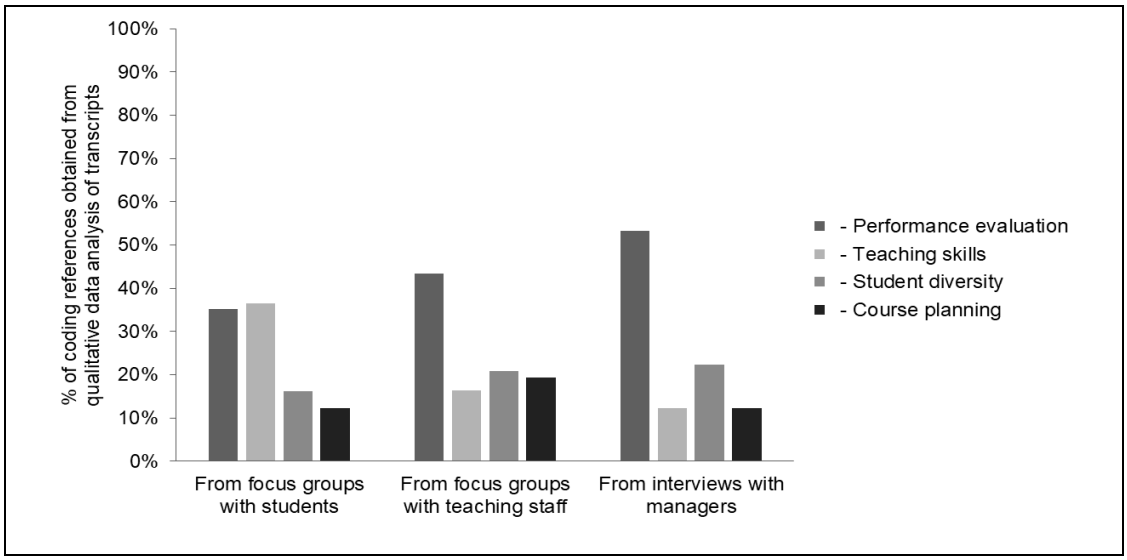

Figure 2-4: Percentage of coding references alluding to teaching staff's needs for LA adoption

2.5.3. Managers' perspectives on needs for LA services

Regarding managers' needs the analysis indicates that they need quality and actionable information from staff to evaluate if support interventions are needed and how effective they are when implemented (finding 1.5 in Table 2-3). Figure 2-5 shows that, unlike both students and teaching staff, who mostly reported references on student support, managers alluded to their need for better information to evaluate support interventions. Some quotations reflect this need, asking for more information about the teaching staff's experience and workload to balance student support and teaching staff workload:

"It would be interesting to know what proportion of the teaching staff are also counsellors or tutors in each faculty. This would allow me to determine a common standard, or to know why there is more in one faculty compared to others. For example, I ask myself, why is there more in one faculty? Why he has more projects, fewer projects? Questions about the load of ... Then, I could manage how many students per teacher. I would like that kind of data." *(Manager, U3)*

"I think there has to be a joint work to identify what is the information that can be practical, useful, and relevant; and how it could be delivered by the Offices for Institutional Analysis or the Academic Registry in a fluid way to the academic units, so they can make decisions or undertake actions, or interventions." *(Manager, U1)*

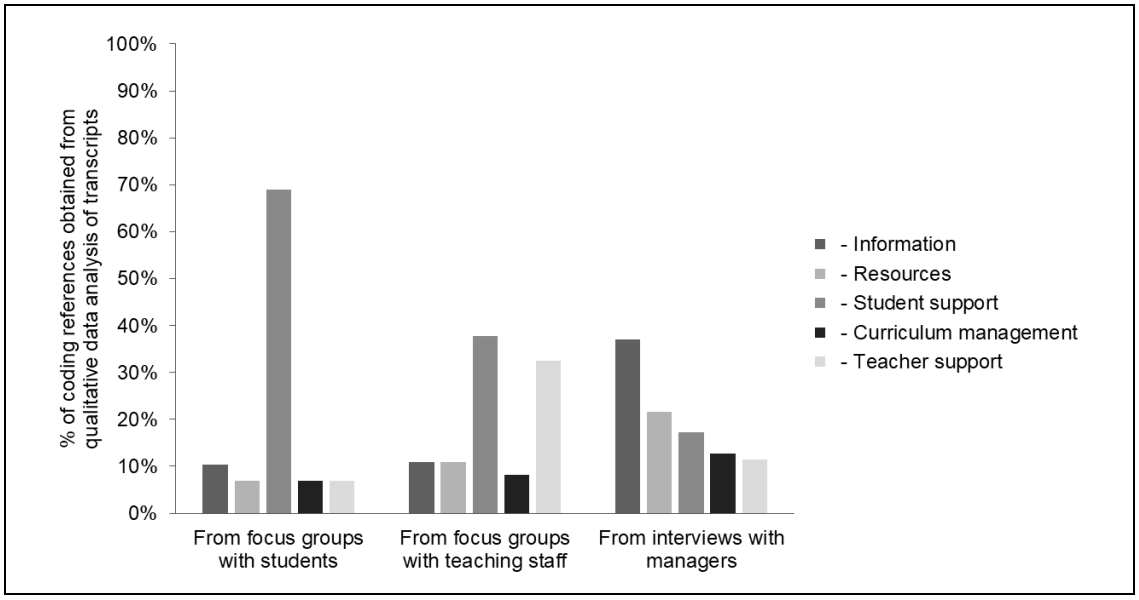

Figure 2-5: Percentage of coding references alluding to managers' needs for LA adoption

2.6. Discussion and limitations

By triangulating the data collected from four different Latin American universities, we identified needs for LA services that have been previously documented in literature, regardless of the fact that this literature has been generated primarily outside of this region. First, students need quality feedback and timely support to improve their academic performance (Findings 1.1 and 1.2 in Table 2-3), which could allow them to reflect on their learning (Bodily & Verbert, 2017; Jivet et al., 2018). Second, teaching staff need timely alerts to assist students enrolled in their classes (M. Brown et al., 2018; Pistilli & Heileman, 2017), besides meaningful evaluations of the quality of their teaching (Findings 1.3 and 1.4 in Table 2-3) (Tsai et al., 2018). And third, managers need high-quality information to evaluate if support interventions are required and well-implemented (Finding 1.5 in Table 2-3), so they can improve institutional performance (Ifenthaler, 2017; Tsai et al., 2018). The fact that stakeholder's needs are associated to existing literature, opens a window of opportunity to integrate existing LA tools in current educational practices (Viberg et al., 2018).

Furthermore, the needs identified in this study could be addressed by adapting existing LA services to Latin American contexts. Respecting students' needs, current research shows that LA solutions have already been developed to provide students with feedback on their learning results (Bodily & Verbert, 2017; Jivet et al., 2018). Regarding teaching staff needs, LA solutions have also been developed to help teachers to evaluate the effectiveness of their teaching practices, regarding their interest in student engagement with learning materials (Tsai et al., 2018). Existing LA solutions integrate different sources of educational data, such as student demographics and their interactions with Learning Management Systems, so staff can reflect about their teaching based on students' characteristics and behaviours (B. T. M. Wong, 2017). Concerning managers' needs, there are LA solutions to evaluate when a support intervention is needed in a specific course when course-level results are impacting outcome attainment at a program level (Pistilli & Heileman, 2017). Along these lines, our findings not only suggest that LA solutions could be actually

used to tackle persisting challenges related to changing student demographics (Cobo & Aguerrebere, 2018; Gašević, 2018), but also to improve existing academic tasks, such as grading, tutoring, and resource allocation for student support services.

As a consequence, these findings contribute to shifting LA research from tool development towards understanding stakeholder experiences with LA services. So far, most studies in Europe have focused on the supply side, documenting the design and development of analytical tools and predictive models that could potentially improve learning results (Ferguson et al., 2016). Conversely, this study has focused on the demand side, highlighting needs for LA tools in Latin American universities. Still, the findings of this study are subject to a couple of limitations. First, this study presents findings obtained from four flagship universities in Chile and Ecuador. Although these universities are relevant to the system as a whole by serving as benchmarks (Knobel & Bernasconi, 2017), other institutions would have to analyse if these findings resonate with their contexts. Second, there is a lack of previous research to contrast the needs that were identified in this study. This is why similar needs analysis should be done in other type of institutions and from different countries; not only to evaluate the extension of the findings of this study, but also to explore further how the adoption of LA actually helps to improve student learning and program quality.

Additionally, future work should focus on closing the policy gaps concerning the difficulties to access and protect educational data. Although it was not the main focus of this study, stakeholders who participated in the data collection process revealed data-related challenges that need to be addressed towards future adoption of LA. These challenges include the lack of policies to ensure informed consent and data transparency; both aspects that have already been identified as key elements for planning the implementation of LA solutions (Drachsler & Greller, 2016). In order to overcome these challenges, we recommend that Latin American universities consult existing regulations and codes of practice to design and implement data protection policies, having in consideration the Brazilian General Data Protection Law enacted in 2018, and the European GDPR. Further ethical guidelines are also presented in the LALA framework developed by Pérez-Sanagustín et al. (2018).

3. DESIGNING A CURRICULUM ANALYTICS TOOL TO IMPROVE PROGRAM QUALITY IN LATIN AMERICAN UNIVERSITIES

This chapter presents the design-based research followed to meet **research objective 2 (RO2 in Figure 1-1)**: *to design and evaluate a curriculum analytics tool to support continuous curriculum improvement of higher education programs in Latin America*. First, this chapter provides a literature review on curriculum analytics, in addition to describing existing curriculum analytics tools that have been designed by researchers and vendors for managers, teaching staff, and students. Second, the chapter describes the two-cycle structure implemented to answer **research sub-question 2 (RQ2 in Figure 1-1)**: *How does a curriculum analytics tool impact continuous curriculum improvement in higher education settings?* Third, this chapter reveals the lessons learned from two cycles, increasing the empirical evidence about the uses and the perceived usefulness of curriculum analytics tools. Finally, this chapter discusses implications for higher education institutions aiming at adopting curriculum analytics solutions to improve student learning and program quality.

3.1. Literature review

3.1.1. The growing field of curriculum analytics

In 2016, CA formally emerged as a sub-field of LA (Greer, Molinaro, et al., 2016). That year, Greer, Molinaro, Ochoa and McKay proposed the first workshop about LA for curriculum and program quality improvement to the program committee of the sixth international conference on Learning Analytics and Knowledge (LAK) (Greer, Molinaro, et al., 2016).[1] This workshop proposal was accepted, and as a result, seven papers were presented about analytical tools and metrics to support continuous curriculum improvement (three papers from North America, two from Australia, one from Europe, and one from Latin America). Along with describing

[1] LAK is a conference held in cooperation with the Association for Computing Machinery (ACM) to debate with a wide variety of stakeholders about the state of the art at the intersection of Learning and Analytics (https://www.solaresearch.org/events/lak/).

relevant indicators and tool features, this papers also discussed future work to create approaches to engage managers and teaching staff in making data-based decisions to improve student learning at a program-level (Greer, Molinaro, et al., 2016).

Since then, CA has consisted of collecting, analysing, and visualizing educational data to drive curriculum-decision making and program quality improvement (Ochoa, 2016). This implies using educational data to drive improvements in both course instructional design and academic program delivery, increasing student outcome attainment in the long term. These educational data are obtained from several sources of information at a course- and at a program-level (Greer, Molinaro, et al., 2016). Course-level data consists of course syllabi, course enrolment, and student grading; while program-level data consists of course selection, curriculum maps, and student outcome matrixes (describing the relationship between course courses and competencies that students have to develop according to the graduate program profile).

The recent creation of LA dashboards and systems that aggregate program- and course-level data create an unprecedented opportunity to develop CA tool and methods (M. Brown et al., 2018). So far, some studies on curriculum analytics have used these aggregated data to explore how students take courses throughout different academic periods (M. Brown et al., 2018; Dawson & Hubball, 2014; Heileman et al., 2017). However, most teaching staff members do not yet have structured tools to collect and analyse data, what limits their capacity to reflect on their students' outcome attainment (Bouwma-Gearhart & Hora, 2016). Therefore, it is still an open question whether these studies contribute to continuous curriculum improvement from the perspective of managers and teaching staff (M. Brown et al., 2018).

In this context, the early CA promise of driving continuous curriculum improvement has not been completely fulfilled, and curriculum analysis remains manual and course-specific (Gottipati & Shankararaman, 2017). Regardless of the potential of using analytical tools to gain better understanding of the effectiveness of curriculum strategies and program outcomes, its overall impact on continuous curriculum improvement remains unknown (Sclater, 2018). On the one hand, stakeholders' perceptions and preferences are still the main sources of information to be used for

the revision of the higher education curriculum (Ochoa, 2016). On the other hand, managers and teaching staff have not been widely exposed to the use of these tools, so they do not necessarily understand the capabilities and limitations of its use to drive improvement actions (Greer, Molinaro, et al., 2016). Thus, more research is needed to understand how CA tools could support continuous curriculum improvement in real-world university settings.

3.1.2. Curriculum analytics tools in higher education

Over the past five years, researchers have developed different type of CA tools for managers, teaching staff, and students. Table 3-1 presents some examples of CA tools that have been described as part of the proceedings of the first LA workshop for curriculum and program quality improvement (Greer, Molinaro, et al., 2016), and subsequent work (Chou et al., 2015; Gottipati & Shankararaman, 2017; Pistilli & Heileman, 2017). Most tools target managers and teaching staff, providing them with program-level information such as risk indicators (e.g. retention rates, completion time) (W. Y. Wong & Lavrencic, 2016), student flows through academic programs (Greer, Thompson, et al., 2016; Heileman et al., 2015), and graphical representations of course sequence patterns (Heileman et al., 2017).

Some of these tools CA tools provide managers, teaching staff, and students with information about student outcome attainment. For example, the Visualized Analytics of Core Competencies system provides students with radar charts about their competency attainment in terms of grades, credit hours, and peer performance (Chou et al., 2015). Then, the Competency Analytics tool provide managers and teaching staff with a model to analyse the entire curriculum in terms of course competencies and progression levels (Gottipati & Shankararaman, 2017). In order to collect evidence for continuous curriculum improvement, educational technology vendors have also developed systems for planning assessment of student learning outcomes at a course-level. These vendors mostly come from North America, such as Ellucian and eLumen, and they are starting to offer outcome-based solutions to monitor the quality of higher education programs.

Regardless of all these efforts made by researchers and vendors, little is known about how these tools contribute to institutional processes for improving curriculum practices and program outcomes. On the one hand, some of these tools are still in a prototyping phase (Molinaro et al., 2016), or implemented on a small scale (Liu et al., 2016). On the other hand, other tools have been evaluated in terms of use and student performance, without establishing a clear relationship between usage and improved outcomes (Jisc, 2013). With this in mind, some researchers have reported user perceptions and use cases (Chou et al., 2015; Greer, Thompson, et al., 2016; W. Y. Wong & Lavrencic, 2016), without necessarily reporting data about its impact on program design or academic program delivery. Given the current literature, researchers agree that more robust design-based research is needed to evaluate LA and CA tools, in order to understand how these tools encourage evidence-based practices for continuous curriculum improvement — from initial tool conceptualization to its institutional adoption (Greer, Molinaro, et al., 2016; Rienties et al., 2016).

Table 3-1: Examples of Curriculum Analytics Tools

Aim of the tool	**Tool name**	**Tool Developer**
Provide managers and teaching staff with models to analyse the curriculum design in terms of course sequence or competencies	Curricular Analytics (Heileman et al., 2017)	University of New Mexico, USA
	Competency Analytics Tool-CAT (Gottipati & Shankararaman, 2017)	Singapore Management University, Singapore
Provide managers and teaching staff with interactive visualizations of student flows through academic programs	The Ribbon Tool (Greer, Thompson, et al., 2016)	UC Davis, USA
	Student Flow Diagrams (Heileman et al., 2015)	University of New Mexico, USA
Provide managers and teaching staff with program- and course-level information	Risk Management Model (W. Y. Wong & Lavrencic, 2016)	The University of Quensland, Australia
	Departmental Diagnostic Dashboard (Molinaro et al., 2016)	UC Davis, USA
Provide teaching staff with student information (demographics, academic performance, etc.)	Student Relationship Engagement Systems (Liu et al., 2016)	University of Sydney, Australia
	Know your students (Molinaro et al., 2016)	UC Davis, USA
Provide students with information regarding their academic	Course Signals (Jisc, 2013)	Purdue University, USA (licensed to Ellucian)

Aim of the tool	Tool name	Tool Developer
performance in different courses	Visualized Analytics of Core Competencies-VACCs (Chou et al., 2015)	Yuan Ze University, Taiwan

3.2. Study design and objective

This study addresses the following research sub-question **(RQ2)**: *How does a curriculum analytics tool impact continuous curriculum improvement in higher education settings?* In order to answer this research question, we followed a design-based research (DBR) approach. DBR is not a methodology itself, but research approaches whose interventions lie within a wide range of methodologies. These methodologies blend empirical educational research with theory-driven design of learning environments by using mixed methods, testbeds and experiments. From a DBR perspective, we applied the Integrative Learning Design (ILD) Framework developed by Bannan-Ritland (2003). This framework has already been used in prior studies to evaluate mobile technologies and LA tools (Pérez-Álvarez et al., 2018; Pérez-Sanagustín et al., 2016; Roschelle et al., 2010). This framework is organized in four phases: 1) informed exploration, which studies the needs of intended users for a particular tool or intervention to support their learning goals, 2) enactment, which consists of the design of a technological tool to collect feedback from unsolicited users; 3) evaluation of local impact, which aims to evaluate the impact of the intervention from the perspective of the intended users at a local level for an extended period of time, and 4) evaluation of broader impact, which evaluates the consequences of adoption of the technological intervention to a wider audience.

In this study, these four phases were organized in a two-cycle structure (see Figure 3-1). First, we conducted an informed exploration phase by using the persona technique. This phase led to a first cycle, in which a CA tool was developed and evaluated in one Latin American university. Then, a second cycle was implemented to redesign the CA tool developed during the first cycle, besides evaluating its perceived usefulness in two university settings. Finally, a broad evaluation phase was conducted to document lessons learned from both cycles, in addition to discussing the implications of using the tool to support continuous curriculum improvement in

different higher education institutions. The following sections describe each one of the phases and cycles, besides presenting its main results.

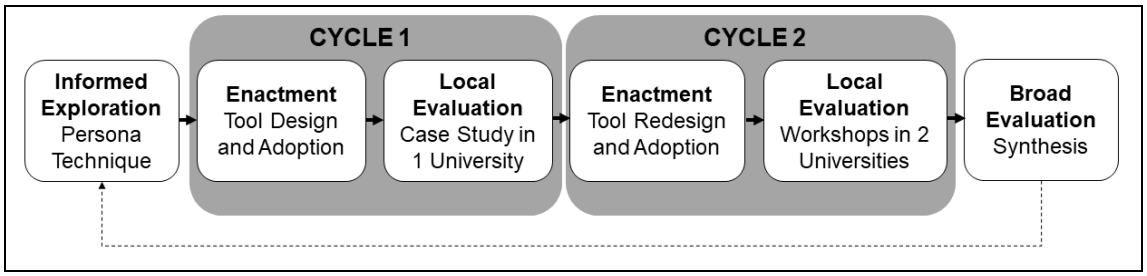

Figure 3-1: Design-based research approach based on the Integrative Learning Design Framework

3.3. Informed exploration

The first phase consisted of identifying users' needs for a CA tool by using the persona technique. This technique was introduced into software development by Alan Cooper in the early 1980s, aiming to create user archetypes based on shared goals and behavioural patterns (Calabria, 2004). These archetypes are used to inform developers' choices based on user needs, proving the improvement of the user experience and adoption of the designed tools (Calabria, 2004).

In order to identify personas and their needs for a CA tool, we used a convenience sampling method to collect qualitative information from different higher education stakeholders. First, we conducted three group interviews in three different universities with eight managers (in charge of curriculum decision-making, but not necessarily teachers): two in Chile, three in México, and three in Panamá. Then, we applied a paper-based survey to 25 teaching staff members and 51 students affiliated to a large and selective university in Chile. Both the interview and survey included the following questions: 1) How would you use a CA tool? 2) What kind of information and functionalities would you expect from this type of tool?

The qualitative information collected from interviews and surveys was analysed by two researchers, who created personas in terms of the potential uses that they would give to the CA tool. By categorizing potential uses, we found that managers and teaching staff emerged as primary personas for a CA tool, whereas current and future

students emerged as secondary personas. This means that the design of a CA tool should prioritize interfaces for managers and teaching staff (see Figure), considering that their needs will not be met if you design a CA tool for someone else (Calabria, 2004). However, if you add few specific features to those interfaces, such as course-level indicators (W. Y. Wong & Lavrencic, 2016), you could also meet the needs of current and future students for course and program enrolment respectively.

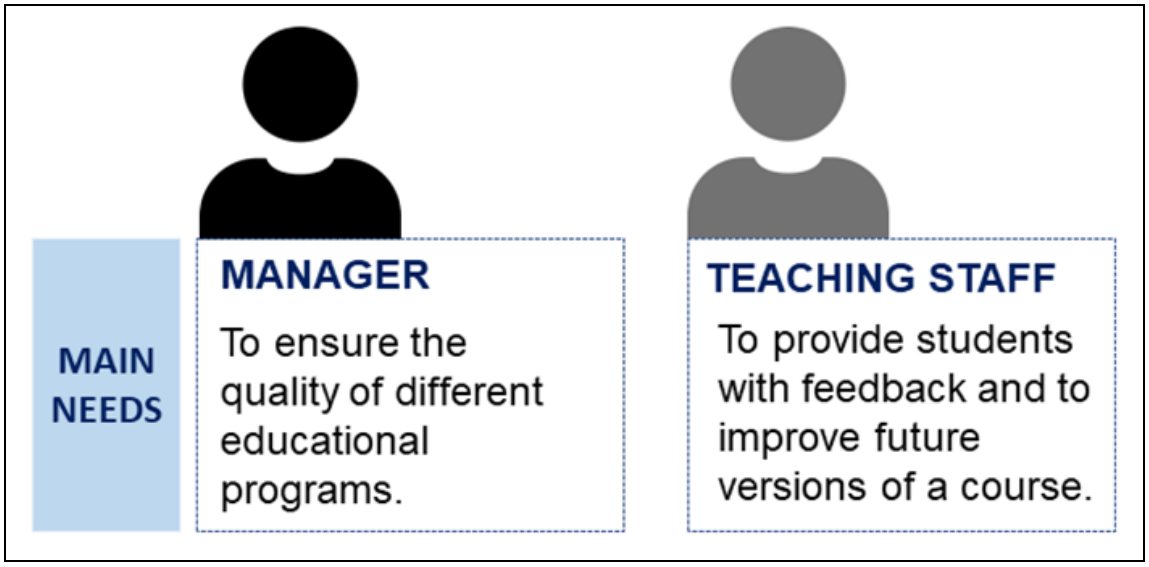

Figure 3-2: Primary intended users of a curriculum analytics tool

3.4. First cycle

3.4.1. Enactment

This phase consisted of developing a first version of a CA web-based tool based on the results of the informed exploration phase. This tool was developed jointly with a Chilean vendor that offers technological solutions and research services to higher education institutions, and it is based on a prior CA tool of the University of Sydney (Gluga et al., 2010). It conveys program-level and course-level information about student competency attainment to support continuous curriculum improvement in higher education institutions. To gather all this information, this tool is organized in four entities: 1) Administration, 2) Competencies, 3) Study Plans (Programs), and 4)

Course Syllabus. Figure 3 presents these five entities and the main tasks undertaken by intended users.

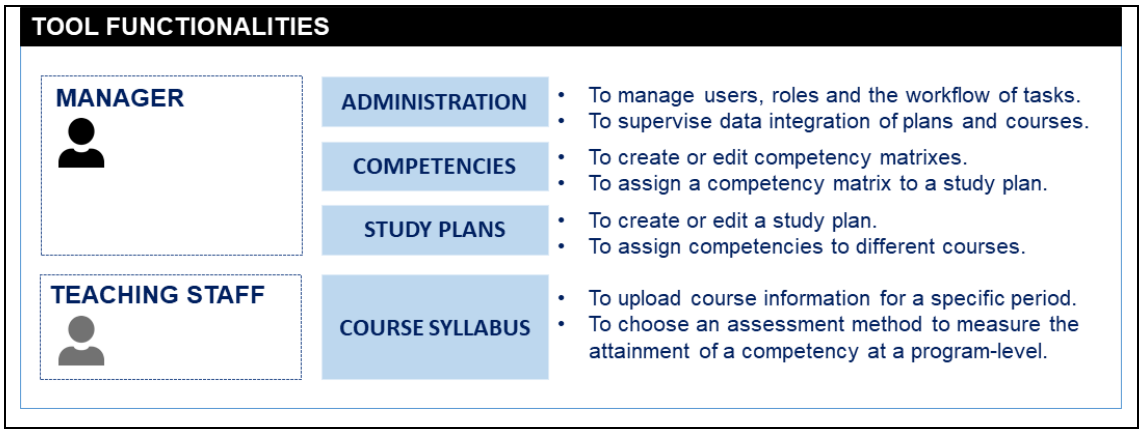

Figure 3-3: Entities and main functionalities of the curriculum analytics tool (https://youtu.be/WEZdBdyOLfk)

Besides the tool functionalities described in Figure 3-3, this tool generates an automated report of competency attainment at a course-level (https://youtu.be/WEZdBdyOLfk). In order to generate this report, teaching staff have to undertake the following tasks at the beginning of the academic period:

- Indicate the relationship between competencies at a program-level and learning outcomes at a course-level.
- Choose an assessment method to measure the learning results associated to the program-level competency.
- Once the teaching staff has chosen an assessment method, the CA tool integrates the assessment method grades from the institutional LMS by using a process of Extract, Transform, Load (ETL). Then the CA tool transforms these grades into a percentage of competency attainment according to the following equation:

$$\% = \frac{Assessment\ Method\ Grade * 100}{Maximum\ Grade} \quad (3.1)$$

3.4.2. Local Evaluation

Study design and objective

In this phase, the objective was to evaluate how the use of the CA tool could support continuous curriculum improvement in a real-world university setting. In order to meet this objective, we conducted an instrumental case study. This type of study is useful to determine if a technological tool makes it easier to produce something compared to prior scenarios (Zelkowitz, 2009; Zelkowitz & Wallace, 1998). In this case, we specifically evaluated whether the CA tool supported a continuous improvement process that was implemented between the first semester of 2015 and the second semester of 2017.

Study context

This case study took place at an engineering school in a Latin American university (U1). In U1, a continuous improvement process was organized in six semesters (see Figure 4), aiming to collect evidence for the renewal of the accreditation of five engineering programs. Every semester, teaching staff were required to undertake different tasks. At the beginning of the semester, they had to develop an assessment plan to report what assessment method at their courses could be used to account for competency attainment at a program-level. Once the semester finished, they had to report documentary evidence of competency assessment in their courses (e.g. course syllabus, assessment plans, grading spreadsheets), in addition to report percentages of competency attainment based on grades of assessment methods (using the formula described in equation 1). The documentary evidence and the percentages of competency attainment were presented at end-of-semester meetings, in which managers such as program chairs and teaching staff of the same engineering program discussed if improvement actions were needed at course- or program-level.

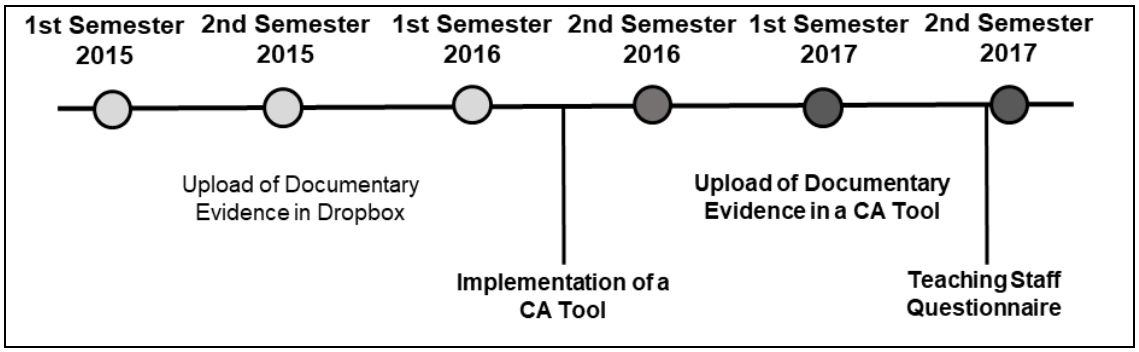

Figure 3-4: Evaluation of the CA tool to support a 3-year continuous improvement process. Light grey dots indicate the semesters where the teaching staff tasks were not supported by the CA tool, and the dark grey dots the periods where the tool was implemented as part of the process.

Between the first semester of 2015 and 2016, the documentary evidence was uploaded to a Dropbox folder, and the percentages of competency attainment were calculated in spreadsheets. Since the second semester of 2016, the CA tool was incorporated into the continuous curriculum process, in order to facilitate the following activities:

- Filling a course description form to describe broadly the teaching and assessment methods.
- Indicating the relationship between program core competencies and course learning outcomes.
- Listing performance indicator for competencies at a program level that could be assessed at a course level.
- Aligning performance indicators with graded assessment methods at a course level.
- Generating automated reports of competency attainment (this functionality is integrated with the institutional LMS to automatically capture the students' grades).
- Uploading documentary evidence as attachments, including: course syllabus, assessment plans, competency assessment results, and sample of assessment methods.

Participants and data gathering techniques

Between 2015 and 2017, 124 teaching staff members participated in the continuous improvement process implemented at U1. These 124 members included 61 teachers (44 faculty members and 17 part-time instructors) who planned competency assessment and selected documentary evidence of competency attainment in 96 course sections, and 63 teaching assistants who helped teachers to upload evidence in the CA tool once implemented (see Table 3-2).

Table 3-2: Teaching staff involved throughout the continuous improvement process implemented at U1 (before and after the CA tool was implemented)

	Faculty members and part-time Instructors	**Teaching Assistants**
Staff involved in the continuous improvement process(N) (*)	61	63
Staff involved before tool implementation (N)	19	-
Staff involved after tool implementation (N) (**)	30	63
Staff involved before and after tool implementation (N) (**)	12	0

(*) Total number of staff members who reported documentary evidence between 2015 and 2017
(**) Number of staff members who were involved as CA use after tool implementation (42 faculty members and part-time instructors, and 63 teaching assistants)

In order to develop the instrumental case study, data was collected in two steps. The first step consisted in analysing how the CA tool was used to facilitate the collection of documentary evidence. Throughout the six semesters, teaching staff received the same guidelines regarding the collection of documentary evidence, emphasizing the importance of providing at least assessment plans and grades (among other evidence, such as samples of assessment methods and rubrics). This allowed the comparison between the number and the type of documentary evidence generated before and after the CA tool was implemented. To do this, three researchers used a coding scheme to classify the evidence reported by each teaching staff member for each course-section that was involved in the continuous improvement process. This scheme was developed on a bottom-up coding approach, and each category was defined by examining the files uploaded in Dropbox and the CA tool. Six categories emerged from this bottom-up approach: 1) reported assessment plans, 2) reported a

sample of assessment methods, 3) reported competency attainment results (based on grades), 4) reported course syllabus, 5) included a course description, and 6) reported the percentages of competency attainment. The researchers used these categories to assigned scores from 0 to 1 to account for the type of documentary evidence reported every semester (see coding scheme: https://bit.ly/3csAgGC). Then, each course section was assigned a score that ranged from 0 to 6 in each course section, in which a score equal to 0 indicates a minimum amount and variety of evidence (and a score equal to 6 indicates a maximum amount and variety of evidence).

The second step consisted in exploring the perceived usefulness and ease-of-use of the CA tool from the viewpoint from its users. For this purpose, we developed a paper-based questionnaire based on the prior work of Ali, Asadi, Gašević, Jovanović, & Hatala (2013), considering that their objective was also exploring teaching staff's perspectives in a real-life context. Our questionnaire consisted of a closed-ended and an open-ended question section (http://bit.ly/2Jh3VVG). The closed-ended section consisted of a 5-point Likert scale to determine the level of staff's agreement on different items related to perceived usefulness and perceived ease-of-use, while the open-ended section included the following questions to understand usability and ease-of-use implications from an exploratory perspective. Regarding the 5-point Likert scale, we estimated the percentage of respondents who rated a high level of agreement with each of the items. By high-level agreement, we considered respondent scores that were equal to or higher than 4, taking into account that the scale ranged from 1 (strongly disagree) to 5 (strongly agree).

Results of the first cycle

The results of the document analysis show that the number and the variety of evidence reported per course section increased from two to five after the CA tool was implemented (see Figure 3-5). In most cases, these three additional items included course syllabuses, course descriptions, and the report of student competency attainment. This effort to collect a greater number and variety of evidence did not respond to greater administrative pressure, since U1 managers submitted evidence for accreditation in the first semester of 2016. Thus, all subsequent work was done

solely with the motivation of sustaining the effort to continuously improve the curriculum.

Additionally, the results of the questionnaire show that 92% of respondents agreed with the item ‘In general the CA tool seems useful for curriculum management’ (see Figure 3-6). In the open-ended questions, teaching assistants mentioned that the CA tool facilitated the use of evidence to account for the implementation of a competency-based curriculum throughout the accreditation process. From their perspective, this tool could be potentially used to provide students with information about course methods and its alignment with competencies from the graduate profile. However, they also mentioned usability and functionality issues that affect the ease-of-use of the CA tool. Regarding usability, respondents indicated that the tool views had too many tabs and fields, so the CA tool site was not intuitive enough. Concerning functionality issues, respondents mentioned the lack of information to inform course redesign and assurance of learning, alluding to the need for further indicators to understand student strengths and areas for improvement.

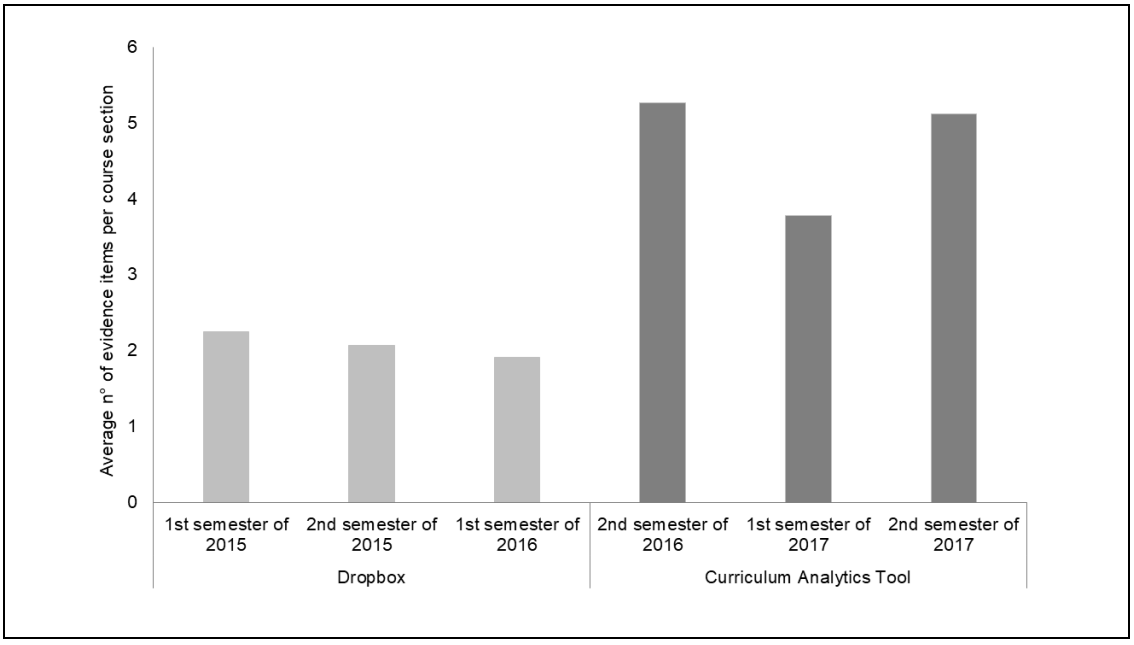

Figure 3-5: Average number of evidence items submitted per course-section each semester

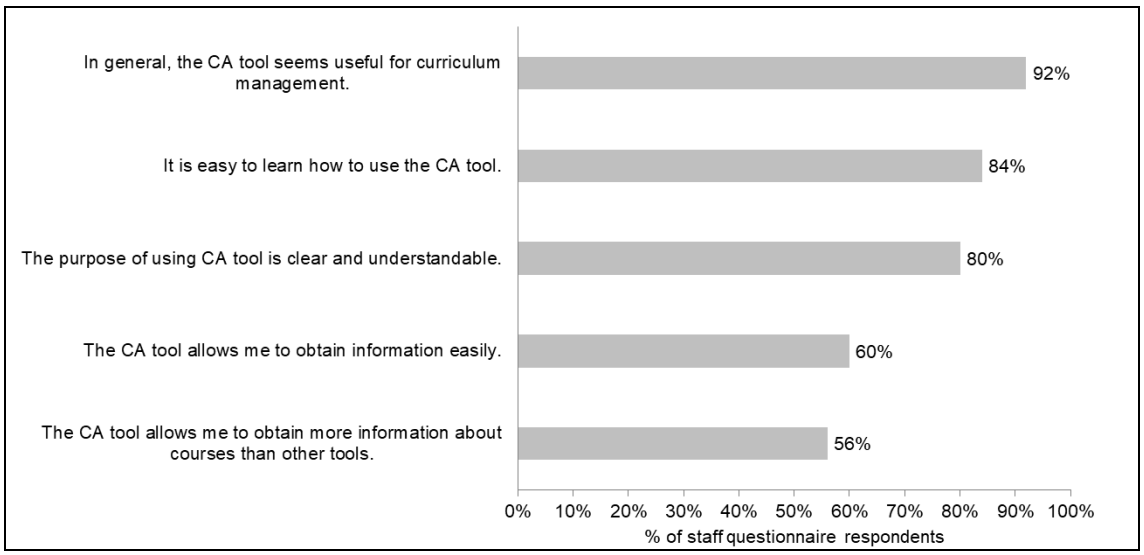

Figure 3-6: Percentage of teaching assistants (N=25) who agreed with the questionnaire items related to the CA tool usefulness and ease-of-use (see questionnaire in http://bit.ly/2Jh3VVG)

Discussion and limitations of the first cycle

The results of this first cycle show that a CA tool could be incorporated into an existing institutional process for continuous curriculum improvement. So far, new CA tools have been introduced to support curriculum decision-making, without necessarily reporting data about their impact on curriculum design or delivery (Ochoa, 2016). In this first cycle, we showed that the results of using a CA tool in a long-term continuous improvement process implemented at a real-world university setting. Findings show that this tool helped teaching staff to collect a greater number and variety of documentary evidence regarding competency attainment. Teaching staff often lack evidence to reflect on their practice (Bouwma-Gearhart & Hora, 2016). In this context, CA tool could provide staff with information regarding student competency attainment to analyse its progress against the graduate profile.

However, the results of this first cycle also show that there are usability and functionality issues that prevent teaching staff from using the tool to obtain information to redesign courses and to reflect about students' performance at a course-level. These needs have already motivated the development of CA tools

(Chou et al., 2015; Jisc, 2013), but more studies are required to better understand what actionable information is useful for a particular context, and how decisions based on that information could lead to program improvement efforts (Pistilli & Heileman, 2017). In these lines, the second cycle not only redesigned the CA tool to make it more intuitive, but also the redesign of the tool included further reports to allow staff to reflect on curriculum and teaching practices.

Additionally, we detected some limitations that could have influenced the results of this cycle. First, data was collected in one Latin American university, so they might not be representative for all educational systems. Second, questionnaire results only represented a small sample of teaching staff members who interacted with the CA tool. In order to address these limitations, we decided to involve other universities that are currently using the CA tool in the second cycle. We also developed a common protocol to understand managers and teaching staff perspectives on how these tools could be used in different institutions, expanding our understanding of the CA application to different contexts. Further details are explained in the following sections.

3.5. Second cycle

3.5.1. Enactment

In this phase, the CA tool was redesigned based on the results of the first cycle. The improved version included the functionality of uploading evidence at a program-level, allowing managers to document curriculum decision-making in the study plan entity. This functionality was added so as to determine whether this information was useful for these stakeholders. Second, this version included a reports entity that provides staff with information regarding student's academic progress and competency attainment. This functionality was proposed to facilitate teaching staff reflection on the curriculum by providing them with statistics regarding past course grades and offering managers information to monitor teachers' updates in their course syllabus. And third, the tool was improved for dealing with the usability issues detected. Specifically, the number of tabs and fields in each entity was

reduced, in addition to make it more intuitive for its users (https://youtu.be/FPzf5NiJR8A).

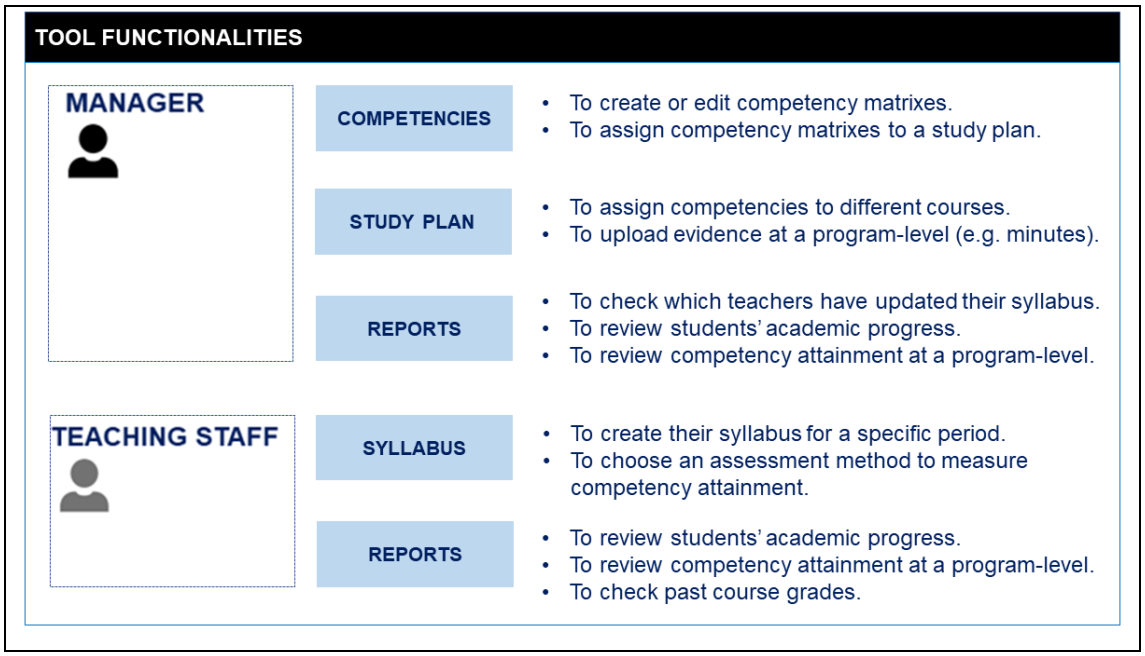

Figure 3-7: Redesign of the CA tool functionalities (https://youtu.be/FPzf5NiJR8A)

Figure 3-7 presents the entities and functionalities of the resulting tool, including: 1) Competencies, 2) Study Plan, 3) Course Syllabus, and 4) Reports (personalized for managers and teaching staff). In this new version, most of the functionalities of the administration entity were automatized throughout the integration of academic data, in order to reduce the task workload for managers. Considering that managers had no longer to supervise data integration and manager users, roles and workflow of tasks; this entity was not included in Figure 3-7.

3.5.2. Local Evaluation

Study design and objective

In this phase, we conducted a field study to involve two different universities in the evaluation of the improved version of the CA tool. According to Zelkowits and Wallace (1998), field studies are useful to determine the effectiveness of a tool to undertake certain actions, so they are often used to determine the effectiveness of a

new tool from the perspective of a subject group. Thus, an outside group monitors the actions undertaken by subject group, without disturbing the actual usage given to the tool in different real-world settings (Zelkowitz, 2009; Zelkowitz & Wallace, 1998).

Study context

In this study, the outside group consisted of three researchers and a representative of the Chilean vendor that developed the first version of the CA tool. This group developed a protocol to collect data during workshops that were held with managers and teaching staff at different Latin American universities (https://bit.ly/2U1FuSj). These workshops were carried out in person under a duration of an hour and a half (approximately), establishing a common methodological approach for all subject groups involved in this study. This approach consisted of (see Figure 3-8): 1) an overview of the improved version of the CA tool, 2) a list of predefined tasks to evaluate the new functionalities of this tool, 3) the application of an online questionnaire with open- and closed-ended questions, and 4) a guided discussion to collect qualitative information on the perception of the participants regarding the usefulness of the new functionalities of the improved version of the CA tool.

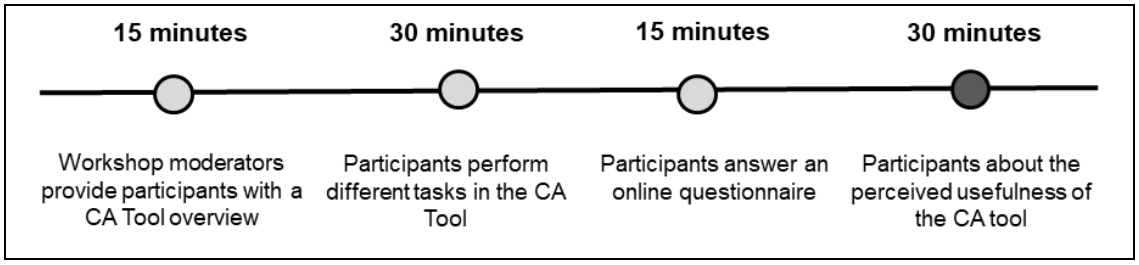

Figure 3-8: Activities carried out during the workshops to evaluate the redesign of the CA tool

Participants and data gathering techniques

We carried out two workshops in two contrasting Chilean universities. These universities not only differed in terms of ownership and administration (private vs public), but also in terms of staff's level of exposure to the CA tool. In workshop 1, we involved 5 managers and 5 teaching staff members affiliated to U1 — the private non-profit university where the tool was initially developed and evaluated in cycle 1.

In workshop 2, we involved 11 managers and 4 teaching staff members affiliated to U2 — a public university where the CA tool was implemented after cycle 1 (see Table 3-2). Table 3-3 summarizes the information of the workshops' participants, in addition to presenting demographic statistics of managers and teaching staff members who were involved in this study.

Table 3-3: Participants of workshops to evaluate the perceived usefulness of the CA tool

	Managers (N=16)	**Teaching Staff (N=9)**
Participated in workshop 1 in U1 (N)	5	5
Participated in workshop 2 in U2 (N)	11	4
Age range	31-60	35-58
Female participants (N)	12	1
Participants familiar with the tool (N)	11	3

In order to develop the field study, we analysed data collected from the online questionnaire and the discussion held at the end of workshops (see Figure 3-8). The online questionnaire was based on the Evaluation Framework for Learning Analytics (EFLA) developed by Scheffel (2017). This framework was proposed to evaluate the impact of LA services in terms of data, awareness and reflection, and impact; and it has already been used to evaluate LA tools (Broos et al., 2018). Thus, we chose this framework because we were interested in evaluating whether the new version of the CA tool supported the reflection managers and teachers about students' academic progress and competency attainment. Just like in the first cycle, our questionnaire consisted of a closed-ended and an open-ended question section, but the closed-ended section consisted of a 10-point Likert scale based on EFLA (https://bit.ly/2WIkr9o). Specifically, we translated the eight items of the scale for teachers into Spanish, and then we adapted this scale for managers. Regarding the EFLA score, we estimated the score for each subject group (teaching staff and managers) following the steps suggested by the LACE project— Learning Analytics Community Exchange (LACE, n.d.). These steps imply:

- Calculating the average value for each item based on the answers given for that item (scores between 0 and 10).

- Calculating the average for each dimension based on the average of its items (item 1 and 2 correspond to the 'data' dimension, items 3-6 to the 'awareness and reflection' dimension, and items 9 and 10 to the 'impact' dimension)
- Calculating the dimensional scores with the following formula:

$$\text{Dimensional Scores} = \frac{(x-1)}{9} * 100 \quad (3.2)$$

- Calculating the overall EDLA score by calculating the average of three-dimensional scores.

In what respects to the discussion held at the end of the workshops, two researchers analysed the transcripts recorded from both workshops. Then, these researchers used an inductive coding process to generate initial categories of information about the perceived usefulness of the tool (Creswell, 2012). In order to validate these categories, researchers contrasted these categories with participants' answers to open-ended questions in the online questionnaire. Five categories emerged from this grounded theory approach (see coding scheme: https://bit.ly/2LDvHxk): 1) quality assurance of higher education programs, 2) assessment and assurance of student learning, 3) graduate skill attainment, 4) support for international accreditation, and 5) support finally accreditation. In order to identify the prevalent uses that users would give to this new version of the CA tool, researchers analysed the frequency of mentions of each category from the perspective of managers and teaching staff. Besides, quotes from workshop participants were extracted to complement the analysis.

Results of the second cycle

According to the results of the online questionnaire, managers and teaching staff members assessed the improved version of the CA tool with EFLA scores of 76/100 and 85/100 respectively (see Table 3-4). Considering that an EFLA score over 70 could be considered acceptable for a first iteration (Broos et al., 2018), the improved version of the CA tool outperformed the older version, particularly from the perspective of teaching staff members. Teachers assessed the tool impact with a

score over 90, besides assessing the dimensions regarding data and awareness and reflection with scores over 80. Considering the highest scores in each scale item, these results indicate that teaching staff perceived that the CA tool stimulated them to plan their courses more efficiently (average score of 9.22/10), helping them to be more aware of the current learning situation of their students (average score of 8.56/10).

Table 3-4: Results of the questionnaire scale based on the Evaluation Framework for Learning Analytics (see questionnaire in https://bit.ly/2WIkr9o)

Dimensional scores (Out of 100)	**Managers (N=16)**	**Teaching Staff (N=9)**
Data	80	83
Awareness & Reflection	74	81
Impact	75	91
Overall	76	85

Note: Dimensional scores were estimated according to LACE (n.d.) (see equation (3.2).

In order to complement findings obtained from the analysis of the questionnaire, Figure 3-9 shows the results of the analysis of the discussions of workshop participants about the perceived usefulness of the new version of the CA tool. According to these results, 7 managers perceived that the tool was useful for quality assurance of higher education programs, while 6 teachers and 6 managers perceived that the tool is useful for assessment and assurance of student learning.

During these discussions, both managers and teaching staff indicated that they valued the information of the reports generated by the new version of the CA tool:

- (The CA tool) allows managing information in high detail at different aggregate levels, for example, monitoring of course-level data and student academic progress from the perspective of curriculum administration. (Teaching staff, U1)
- (The CA tool) allows monitoring student academic progress, in order to be able to provide them with guidance regarding their professional future, in addition to promoting reflection regarding the pedagogical practices. (Manager, U2)

Managers and teaching staff members also mentioned that the new version was more intuitive and easier to use:

- The visualization of curriculum elements is friendly, in addition to its mapping. (Teaching staff, U2)
- It is friendly and easy to use. (Manager, U1)

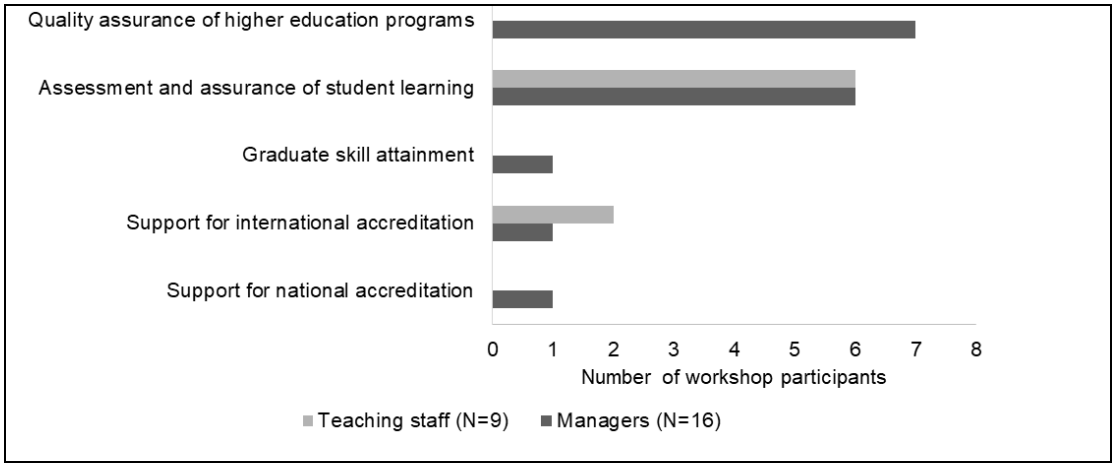

Figure 3-9: Frequency of mentions regarding the discussions about the perceived usefulness of the CA tool (see related coding scheme: https://bit.ly/2LDvHxk)

Discussion and limitations of the second cycle

According to the results of this second cycle, managers and teaching staff perceived that the improved version of the CA tool was useful for assuring program quality and student learning at a course-level. First, workshop participants assessed this tool with EFLA scores over 70, which it has been already considered acceptable in prior studies (Broos et al., 2018). Second, workshop participants mentioned that the tool allows the monitoring of student academic progress at different levels, helping managers and teaching staff members to implement improvement actions. These improvement actions include student academic advising to help students become career ready, in addition to enabling reflective teaching. Considering the current state of art of curriculum analytics, these actions are aligned with the expected benefits from applications in this sub-field (M. Brown et al., 2018; Greer, Molinaro, et al., 2016).

Besides, the results of this second cycle also show that the new version of the CA tool was considered friendly and easy to use by the subject group who participated in

the field study. This group included teachers and managers from different age groups, who have not necessarily been exposed to this improved version of the CA tool. Thus, the improved version might be more intuitive to use than the first version, testing usability aspects that have already been tested in previous tools (Chou et al., 2015). Furthermore, functionality issues were also solved by including the new reports entity. During workshop discussions, both managers and teaching staff mentioned that this functionality was the one that they mostly valued, because it provided them with information that is not necessarily accessible to them in an integrated way. Thus, the integration of program-level and course-level data provides researchers and vendors with an unprecedented opportunity to develop CA tools (M. Brown et al., 2018), which could be used to inform the renewal of curriculum and teaching practices.

Although findings have resulted promising, some limitations were faced during workshop implementation. Initially, researchers planned to implement workshops in four Latin American universities, including a Mexican and a Peruvian university (in addition to the both Chilean universities that participated in this study). However, the Chilean social outbreak interrupted the field study (Barlett, 2018), and the subsequent Coronavirus pandemic interrupted academic activities and travelling to impart the workshops face-to-face in the different university settings (Kandri, 2020). Still, the two universities that were involved during this study allowed us to analyse two contrasting settings, demonstrating consensus in the perceived usefulness of the tool regardless of its differences in terms of administration and level of exposure to the CA tool.

3.6. Broad evaluation and discussion

This study presents the results of a DBR approach to understand how a curriculum analytics tool could support continuous curriculum improvement in higher education settings. Figure 9 describes the key findings extracted from each of the phases of this study. From these findings, we identified several implications to promote the design and implementation of CA tool in other university settings.

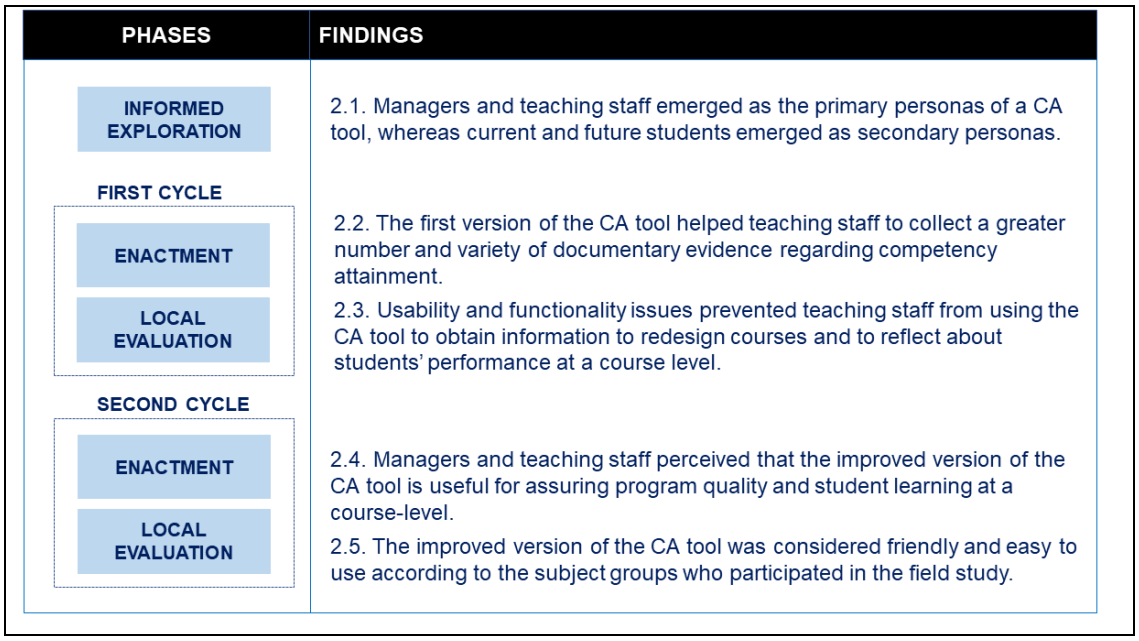

Figure 3-10: Broad evaluation findings regarding the results of the different phases of this study

First, finding 2.1 indicates that teaching staff and managers are the key stakeholders to be considered when designing a CA tool, and that students appear as secondary users. This does not mean diverting attention from the student's learning process, but helping staff to make informed decisions related to the curriculum (Ochoa, 2016). These decisions usually influence students' learning throughout the constructive alignment of student outcomes, assessment methods, and learning and teaching activities. More efforts are needed to engage these stakeholders in the design and implementation of CA tools that can provide information to review and improve the coherence of different curriculum elements (Greer, Molinaro, et al., 2016).

Second, finding 2.2 shows that CA tools could be useful for collecting a greater and wider variety of documentary evidence to analyse how students develop competencies across the curriculum. Over the past few years, studies have indicated that managers and teaching staff often lack of systematic information to monitor outcome attainment at a course- and program-level (Bouwma-Gearhart & Hora, 2016; Chou et al., 2015). This partly explains why these stakeholders merely used their perceptions for curriculum renewal (Ochoa, 2016). For staff to use evidence in their curriculum decision-making, researchers and vendors not only have to explore

user perception and document use cases, but evaluate what information would be useful for staff decision-making.

Along these lines, finding 2.4 reveals that information provided by the improved version of the CA tool resulted useful for assuring program quality and student learning. Taking into account the lessons learned from the first cycle, new reports were incorporated into the CA tool developed during the second cycle, which provided managers and teaching staff with information regarding students' academic progress and competency attainment. This new feature was perceived to be useful for teachers to reflect on how to improve their course design, but also for managers to anticipate the need to guide students regarding their professional future. Future studies have to expose these stakeholders to use this type of tools, so they can understand the capabilities and limitations of using them in their everyday practice (Greer, Molinaro, et al., 2016).

Finally, finding 2.3 indicates that solving usability and functionality issues is key to facilitate users' adoption. So far, some CA tools are still in a prototyping phase (Molinaro et al., 2016), or implemented on a small scale (Liu et al., 2016). In this study, the first version of the CA tool was used in an institutional process, and its use was evaluated over an extended period of time. The results of this evaluation allowed identifying aspects to be improved in a second version of the tool, which was actually perceived to be easy to use according to managers and teaching staff from two different universities (see finding 2.5). This confirms the need for more robust design-based research to develop LA and CA tools, in addition to further studies on the use of these types of tools to reflect on the need to renew curriculum and teaching strategies to improve learning outcome attainment.

4. UNDERSTANDING HOW TEACHING STAFF ENGAGE WITH CONTINUOUS IMPROVEMENT OF CURRICULUM PRACTICES

This chapter presents the case study developed to meet **research objective 3 (RO3 in Figure 1-1)**: *to understand how to engage teaching staff of a higher education institution in Latin America in a process of continuous curriculum improvement*. First, this chapter provides a literature review on teaching staff engagement with student outcome assessment and curriculum decision-making. Second, the chapter describes the case study design used to answer **research sub-question 3 (RQ3 in Figure 1-1)**: *How do mechanisms engage and disengage teaching staff in a higher education institution with continuous curriculum improvement?* Then, this chapter describes the findings that were extracted from the case study, illustrating mechanisms that influence teaching staff engagement and disengagement with continuous improvement tasks. Finally, this chapter discusses practical suggestions that emerged from teaching staff's perspectives, aiming to promote continuous curriculum improvement in different university settings.

4.1. Teaching staff engagement and disengagement with continuous curriculum improvement

Teaching staff engagement in continuous curriculum improvement is important to effectively align curriculum elements towards student outcome attainment (Matthews & Mercer-Mapstone, 2018). Staff background and prior experiences shape their individual preferences and intrinsic motivation to incorporate active learning pedagogies and the delivery of detailed and frequent feedback to their courses (M. G. Brown & Knight, 2014; Hora, 2016). Their individual preferences might also lead them to create their own data gathering techniques to reflect on how to improve their teaching practices at a course level (Barradell et al., 2017; Bouwma-Gearhart & Hora, 2016). In the cases that teaching staff have favourable beliefs regarding this type of strategies, students could benefit from knowing what and how they are developing the learning outcomes they are expected to develop, making sense of their curriculum experience (Matthews & Mercer-Mapstone, 2018).

Still, teaching staff's beliefs on what and how to teach are not only subject to their individual preferences and intrinsic motivation, but also to collective factors that influence their curriculum decision-making (Hora, 2016). Although faculty value their autonomy to plan course-level content and structure, they are also responsive to peer approval and department collegiality (Roberts, 2015; Vican et al., 2020). At a department level, shared-ownership and participatory decision-making allows for provision of mutual support for continuous curriculum improvement of their teaching (Bendermacher et al., 2017). Some of them might even be interested in negotiating curriculum development decisions with their students (Lubicz-Nawrocka, 2018), allowing them to provide real-time feedback on how to improve learning results (Bunce et al., 2017), or to work with them in teaching and learning activities — such as tutoring and the development of instructional resources (Seale, 2016).

However, teaching staff perceive some tension between their logic to make curriculum development decisions and the logic recently adopted by institutional managers to comply with external accountability demands (Vican et al., 2020). Over the past two decades, higher education leadership has become more centralized, moving from shared governance to top-down decision making (Kezar & Holcombe, 2017). As a response to increasing accountability demands and decreasing funding, top-down leadership has favoured managerial practices over teaching and learning enhancement, with the objective of making universities more efficient, effective and client oriented (Bendermacher et al., 2017; Brady & Bates, 2016). Within this context, teaching staff have not been adequately consulted about the learning outcomes students are expected to achieve (Schoepp & Tezcan-unal, 2017; Vican et al., 2020), so they perceive that they have lost autonomy and influence on what is expected as student outcome attainment, as well as the teaching practices to achieve them (Bendermacher et al., 2017; Brady & Bates, 2016). Thus, this lack of teaching staff engagement may be understood as a tension between accountability (driven by the managerial logic) versus improvement (driven by the academic logic).

The emphasis that the leadership has place on efficiency and accountability has also left teaching staff with less time and data to reflect on their curriculum and teaching practices (Barradell et al., 2017; Bouwma-Gearhart & Hora, 2016). On the one hand,

leaders have increased faculty workload including administrative requirements to extend teaching periods, adopt new technologies, and teach a greater number of students (Kenny, 2017; Kezar & Holcombe, 2017; Shay, 2016). On the other hand, leaders have implemented quantitative metrics to evaluate teaching performance in a simple and cost-effective way, such as end-of-course surveys (Barnacle & Dall'Alba, 2017; Bouwma-Gearhart & Hora, 2016). With the increased focus on rising administrative requirements and simplified quantifiable metrics, faculty perceive a devaluation of teaching activities, particularly in institutions that reward research productivity (Bendermacher et al., 2017; Vican et al., 2020). In this context, even motivated teachers have started to disengage from university life, avoiding outcome assessment tasks and program meetings (Schoepp & Tezcan-unal, 2017; Swarat et al., 2017; Vican et al., 2020).

With this in mind, researchers have explored elements for motivating teaching staff to continuously improve teaching and learning practices. Bendermacher et al., (2017) described four mechanisms that could influence teaching staff behaviour towards continuous improvement: 1) shared ownership (opportunities for staff to provide mutual support and to reinforce their teacher identity), 2) empowerment (representation of teaching staff in curriculum decision-making processes or advisory bodies), 3) knowledge (staff understanding of academic plans, instructional processes and curriculum purposes), and 4) staff commitment (staff's dedication to teaching and learning and their continuous improvement at an institutional level). Although these mechanisms indicate what might affect staff motivation with continuous curriculum improvement, their description emerges from theoretical research, without anticipating what they imply in everyday practice. Therefore, more studies are needed to explore how teaching staff engage with continuous curriculum improvement in real-world settings (Bouwma-Gearhart & Hora, 2016; Hora, 2016), as well as to explore their practical suggestions about developing a shared understanding of a quality culture among stakeholders (Bendermacher et al., 2017; Busco et al., 2018).

4.2. Study design and objective

This study addresses the following research sub-question **(RQ3)**: *How do mechanisms engage and disengage teaching staff of a higher education institution with continuous curriculum improvement?* To answer this research question, we adopted a single-case study design. According to Yin (2014), single-case studies are useful to investigate a contemporary phenomenon in real-world circumstances from a longitudinal perspective, allowing researchers to explore how this phenomenon changes over time. In this paper, the main research objective is to investigate teaching staff's engagement with continuous curriculum improvement, exploring how engagement and disengagement mechanisms evolved during a 3-year continuous improvement process implemented at the School of Engineering of the Pontificia Universidad Católica de Chile (UC-Engineering in Chile from now on).

4.3. Study context

UC-Engineering offered favourable circumstances to carry out this single-case study. First, the Chilean quality assurance system has been well studied by national and international scholars and practitioners (Cancino & Schmal, 2014; OECD, 2012). As a consequence of this policy, not only had most Chilean universities voluntarily undergone an accreditation process by 2010, but also other Latin American governments have implemented similar policies to reinforce faculty qualifications and curriculum criteria (Bernasconi & Celis, 2017; Ferreyra et al., 2017). Second, engineering schools provide a convenient context to understand continuous improvement in higher education, considering the influence of the Accreditation Board for Engineering and Technology (ABET) — a non-profit agency that accredits programs in the U.S. and worldwide. Continuous improvement has been a criterion for ABET since the early 2000s (Lattuca et al., 2006), and this case study presents the first attempt of UC-Engineering – the first engineering school that had ABET-accredited programs in Chile – to comply with this criterion.

In 1991, Chile had recently returned to democracy, and the president's committee formulated a proposal to regulate the higher education system (Brunner, 1991). At

that moment, there was no Chilean accreditation agency to certify quality standards, so UC-Engineering authorities perceived that it was convenient to became internationally accredited. In the late 1990s, UC-Engineering authorities decided to comply with ABET quality standards given the presentations of its Engineering Criteria 2000 (Lattuca et al., 2006). Then, in 2007 and 2011, UC-Engineering accredited five academic programs of 11 engineering degrees offered at UC-Engineering: 1) Civil Engineering, 2) Electrical Engineering, 3) Computer Engineering, 4) Mechanical Engineering, and 5) Chemical Engineering. These five academic programs concentrated about 35% of the UC-Engineering undergraduate enrolment, which today accounts for 1,500 students out of a total of 4,000 (average value for the case study period). In terms of teaching staff, these programs concentrated 49% of full-time faculty members (82 out of 169) and 16% of part-time instructors (71 out of 456).

In 2015, ABET mandated a continuous improvement process to renew the accreditation of these five programs. To comply with this mandate, the managers of the Office for Undergraduate Studies and the Engineering Education Unit designed a continuous improvement process to be implemented between the first semester of 2015 and the second semester of 2017. This process was organized in six semesters; every semester, one or two of the 11 student outcomes proposed by ABET Criterion 3 were assessed at a course level (http://bit.ly/2SeVzRj), collecting evidence in at least two courses per program (see details in Fig. 1). The teaching staff who imparted those courses were required to plan the assessment of the student outcome assigned, and to report the results at the end of the semester (‘outcome assessment tasks’). These results were transformed into percentages of student outcome attainment to revise them with the program chair and teaching staff in an end-of-semester meeting (‘curriculum discussions’).

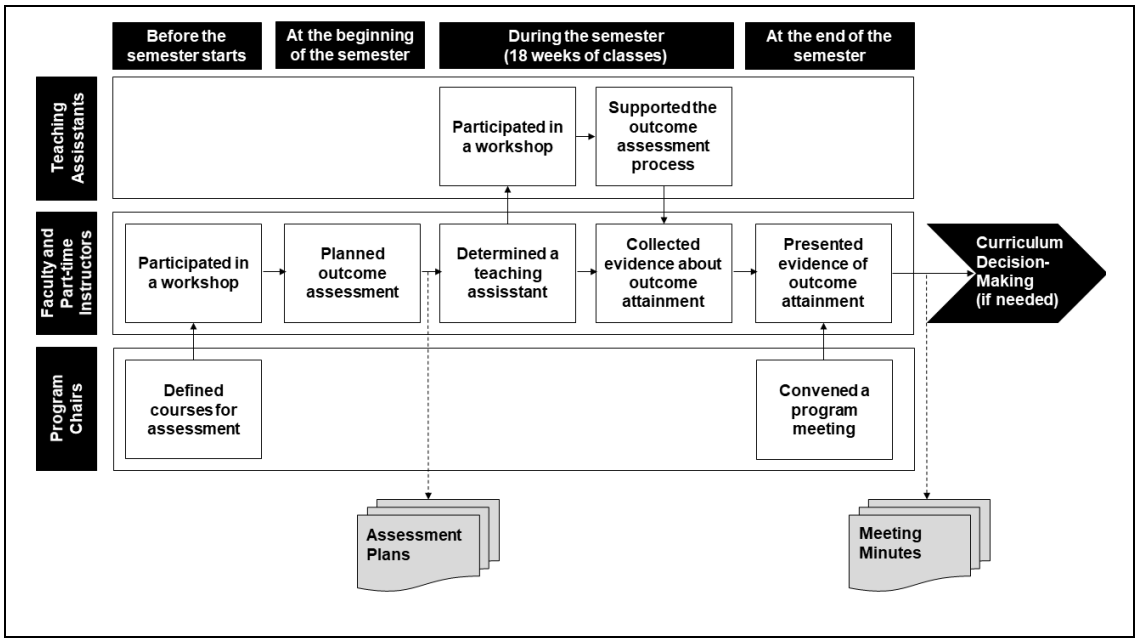

Figure 4-1: Semester tasks that were part of the continuous improvement process implemented at UC-Engineering between 2015 and 2017

Then, the chain of events within the scope of this case study consisted of outcome assessment tasks and curriculum discussions that were undertaken by UC-engineering teaching staff between 2015 and 2017 (see Figure 4-1). Both outcome assessment tasks and curriculum discussions are key practices of continuous improvement processes (Harper & Lattuca, 2010). Concerning the case study, we explored the mechanisms that engaged and disengaged teaching staff with these practices, discussing how they resonate with the working mechanisms of quality culture described by Bendermacher et al. (2017).

4.4. Participants, data gathering techniques and analysis

Between 2015 and 2017, five program chairs, 61 teaching staff members, and 63 teaching assistants were involved in the continuous improvement process. Every semester, program chairs of the five ABET-accredited degrees were involved in defining courses for outcome assessment and convening program meetings, while about 15 teaching staff were involved in both outcome assessment tasks and curriculum discussions (see Table 4-1). Since the second semester of 2016, the Engineering Education Unit started involving teaching assistants in the continuous

improvement process to support teaching staff in collecting evidence of outcome attainment, and about 20 teaching assistants were involved every semester.

Table 4-1: Number of program chairs, teaching staff and teaching assistants who were involved in the continuous improvement process implemented at UC-Engineering between 2015 and 2017

	First semester of 2015	**Second semester of 2015**	**First semester of 2016**	**Second semester of 2016**	**First semester of 2017**	**Second semester of 2017**
Program Chairs (out of 11)	5	5	5	5	5	5
Teaching staff (out of ~150) (*)	15	13	11	15	16	22
Teaching assistants (out of ~150)	0	0	0	31	17	15

(*) A total number of 61 teaching staff members were involved in continuous improvement tasks, including: 44 full-time faculty members and 17 part-time instructors. From those 61 members, 26 were involved for two or more semesters.

During the continuous improvement process, 97 assessment plans were collected from 97 course sections imparted by the 61 teaching staff members involved in outcome assessment tasks. In these assessment plans, the teaching staff declared what course assessment methods they planned to use as evidence for program meetings about curriculum discussions (http://bit.ly/2ACZUXF). These assessment plans were analysed according to a coding scheme developed by three researchers (see coding scheme in https://bit.ly/37UjxdF), which consisted of four categories: 1) high-level of detail included (κ=0,68), 2) non-traditional methods included (κ=0,74), 3) direct and indirect methods included (κ=0,78), and 4) varied methods included (κ=0,78), and kappa's coefficients (κ) among authors were obtained according to the formula established by Fleiss (1971). Authors assigned between 0 and 4 points to each assessment plan (1 point per category), and each 1-point indicated if the assessment plan included what was described by the corresponding category. Then, a score equal to 0 indicated that an assessment plan included a minimum number of assessment methods (without details of outcome assessment tasks), while a score equal to 4 indicated that an assessment plan included a varied number and type of assessment methods described in detail.

From curriculum discussions, 27 meeting minutes were obtained, almost one meeting minute per program per semester. In these meeting minutes, the program chair documented reflections of the teaching staff concerning student outcome attainment and the need for improvement actions (http://bit.ly/2DOS8Nu). These meeting minutes were also analysed according to a coding scheme developed by the three authors (see coding scheme in https://bit.ly/2Vc5vit). The authors classified the notes in the meeting minutes in three categories: 1) reflections on teaching, 2) reflections on assessment, and 3) reflections on curriculum. Although Kappa coefficients were not estimated, two rounds of cross-checking were made to ensure coding reliability.

In addition to collecting assessment plans and meeting memos, individual semi-structured interviews were conducted during 2018 with a stratified sample of teaching staff members (http://bit.ly/2BCrCWc). A purposive sample of 15 teaching staff members was obtained out of the 26 who were involved in the continuous improvement process for two or more semesters, considering three representatives per engineering degree (see Table 4-1). By purposive sample, we mean a type of non-probability sample that can be logically assumed to be representative of the population (Lavrakas, 2013). Finally, 11 teaching staff members participated voluntarily in these interviews: two faculty members of Civil Engineering, one of Computer Engineering, three of Electrical Engineering, three of Mechanical Engineering, and two of Chemical Engineering (the other four staff members were not available during the fieldwork). These interviews were mainly about the impact of involving teaching staff in continuous improvement tasks, and they were conducted by a moderator and a research assistant, who obtained notes and audio files under the informed consent of participants (http://bit.ly/2E1w3ME). The audio files were transcribed verbatim, and the interview responses were summarized into a report that was used by the authors to discuss the first version of the first coding scheme (http://bit.ly/2Q4xr7i). After three rounds of coding comparisons among authors, the coding scheme evolved into the one presented in Table 4-2. Coding comparisons and final coding were conducted in NVivo Pro 12, and a hierarchy chart was obtained to identify the predominant mechanisms used to engage and disengage teaching staff in the continuous improvement process. Still, quotes were extracted to

complement the quantification of qualitative results (Maxwell, 2010; Sandelowski, Volls, & Knafl, 2009).

Table 4-2: Coding scheme to analyse semi-structured interviews

Category/Code	Code description
Engagement mechanisms	
Improving teaching and learning at different levels	Comments on teachers valuing the opportunity to improve teaching and learning at a course or program level (e.g. improving assessment practices, revising the curriculum map etc.).
Leveraging faculty practices	Comments on the need or the appreciation of leveraging existing faculty practices in the continuous improvement process, such as program meetings and faculty luncheons.
Providing reflection opportunities	Comments on teachers valuing the opportunity to reflect individually or with other colleagues (e.g. curriculum discussion meetings, outcome assessment workshops, etc.).
Providing support	Comments on the appreciation of teaching support offered during the continuous improvement process, including guidelines and stipends for teaching assistants, administrative support or other resources.
Recognizing teaching	Comments on the acknowledgement of teaching efforts towards continuous improvement in student evaluations of teaching, academic promotion or teaching recognition awards.
Disengagement mechanisms	
Adding extra work	Comments on extra work added to the current faculty workload by the continuous improvement process, and the notion of faculty overload.
Focusing on prestige	Comments on teachers disengaging with the continuous improvement process because ABET's focus is on prestige, rather than actually benefiting the institution and its students.
Misaligned institutional policies	Comments on teachers disengaging due to the existence of contradictory logics between institutional policies (e.g. faculty promotion based on end-of-course surveys) and continuous improvement tasks.
Responding to external demands	Comments about teachers disengaging due to having to respond to ABET accreditation criteria or other external demands, rather than focusing on internal requirements.

4.5. Results

Table 4-3 describes the two engagement (findings 3.1 and 3.2) and the two disengagement mechanisms that were identified (findings 3.3 and 3.4) by triangulating the coding results of semi-structured interviews, assessment plans, and meeting memos. Due to the coexistence of engagement and disengagement mechanisms, teaching staff exhibited varying levels of engagement in outcome

assessment tasks over time. Figure 4-2 shows the disparities in the coding results of assessment plans throughout the continuous improvement process, in which a score equal to 0 indicates a minimum level of engagement with outcome assessment tasks (providing a minimum number of assessment methods without further detail), and a score equal to 4 indicates a maximum level of engagement (providing a varied number and type of assessment methods described in detail). Thus, teaching staff invested more efforts in outcome assessment tasks at the beginning and at the end of the continuous improvement process, engaging with continuous curriculum improvement under the predominance of specific mechanisms.

Table 4-3: Findings obtained by triangulating coding results of semi-structured interviews, assessment plans, and meeting memos (see supporting data in http://bit.ly/2AaA3XC)

Findings	Coding results	Supporting data
3.1. Teaching staff engage with continuous improvement tasks when data collection is focused on improving teaching and learning at different levels.	56% of coding references alluded to collecting evidence to improve courses and academic programs (75 out of 134 coding references within the category of engagement mechanisms).	Coding of semi-structured interviews (see supporting data)
	59% of assessment plans included various types of assessment methods (57 out of 97 assessment plans coded).	Coding of assessment plans (see Figure 4-3)
	52% of reflections alluded to the need to improve assessment methods at a course level (44 out of 85 reflections coded).	Coding of meeting minutes (see Figure 4-4)
	31% of reflections in curriculum meetings alluded to the need to improve curriculum alignment at a program level (26 out of 85 reflections coded).	Coding of meeting minutes (see Figure 4-4)
3.2. Teaching staff engage with continuous improvement tasks when they receive support for their teaching practices.	56% of assessment plans included non-traditional assessment methods (54 out of 97 assessment plans coded)	Coding of assessment plans (see Figure 4-3)
	27% of coding references alluded to the need for teaching support (37 out of 134 coding references within the category of engagement mechanisms).	Coding of semi-structured interviews (see supporting data)
	18% of reflections alluded to the need for support to improve teaching methods (15 out of 85 reflections coded).	Coding of meeting minutes (see Figure 4-4)
3.3. Teaching staff disengage with continuous improvement tasks when institutional	45% of coding references alluded to staff disengaging when institutional policies were misaligned (49 out of 109 coding references within the category of disengagement mechanisms).	Coding of semi-structured interviews (see supporting data)

Findings	Coding results	Supporting data
policies are misaligned, forcing them to respond to contradictory logics.	29% of assessment plans included both direct and indirect assessment methods (28 out of 97 assessment plans coded).	Coding of assessment plans (see Figure 4-3)
3.4. Teaching staff disengage with continuous improvement tasks when their main purpose is to respond to external demands.	28% of coding references alluded to staff disengaging with continuous improvement tasks when the main focus was ABET accreditation (30 out of 109 coding references within the category of disengagement mechanisms).	Coding of semi-structured interviews (see supporting data)
	22% of assessment plans included high-level of detail (21 out of 97 assessment plans coded).	Coding of assessment plans (see Figure 4-3)

Note: Different tactics proposed by Yin (2014) were followed to ensure construct validity and reliability, including the triangulation of three sources of evidence and the documentation of the case study protocol (http://bit.ly/2T6dVo1) and its data base (http://bit.ly/2AaA3XC).

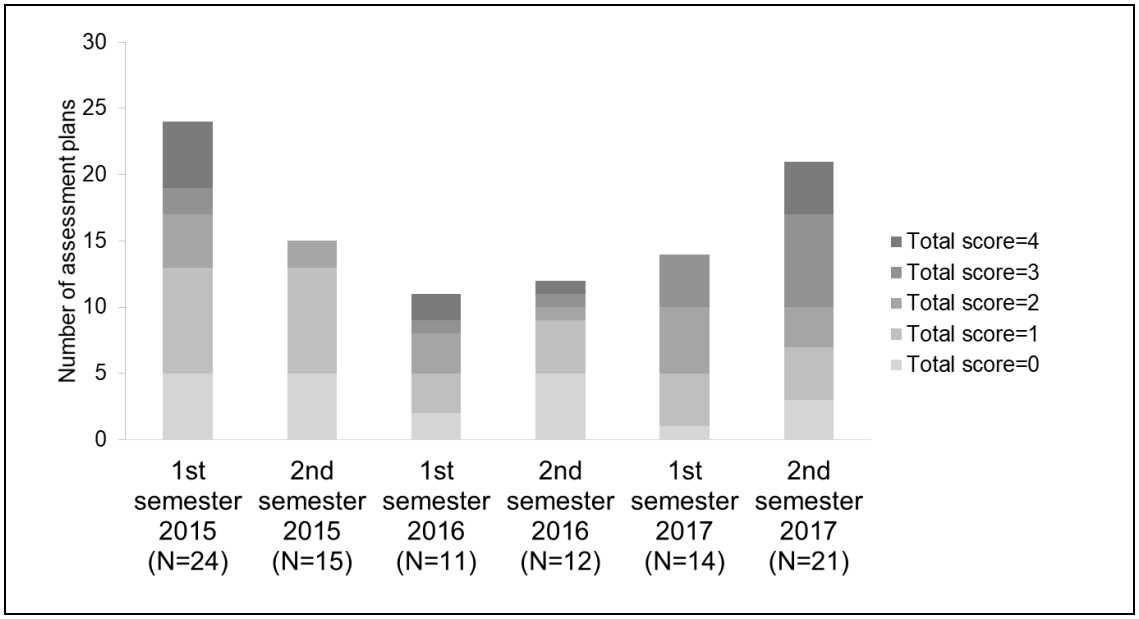

Figure 4-2: Disparities in the coding results of the assessment plans throughout the continuous improvement process (a score equal to 0 indicates that an assessment plan had a minimum number of assessment methods, while a score equal to 4 indicates that an assessment plan included a varied number and type of assessment methods)

Regarding the engagement mechanisms, finding 3.1 reveals that teaching staff engaged with continuous improvement tasks when data collection efforts were perceived as mainly invested in improving teaching and learning at different levels. Throughout the continuous improvement process, 59% of teaching staff members used varied types of assessment methods to collect evidence of outcome attainment in their courses (see 'varied methods included' in Figure 4-3), and 57% of teaching

staff reflections during end-of-semester meetings alluded to the need for a better alignment between learning outcomes and assessment methods (see 'reflections about assessment' in Figure 4-4). This is mostly due to teaching staff feeling accountable for student learning, as it was mentioned by some staff members during the interviews:

"It is essential that the teacher has clarity of (…) what the students must achieve at the end of the course and what are the means that the teacher is going to give them, so they can achieve them (…) The student has to do his part, that is irreplaceable, but it is also important that the teacher offers the tools, so the students — doing their part — can achieve those skills. In that sense (the continuous improvement process) helped me to be more aware of that." *(Interviewee 7, Civil Engineering Program)*

"At some point, the teacher has to take charge of what happened in his semester, for better or for worse. If suddenly all students are very well evaluated, or a significant number of students have low-levels of competency attainment, I think you have to be transparent with other colleagues to understand what is happening (…) I think (the continuous improvement process) is good because it allows us to monitor all the courses that are being imparted by the department more quantitatively and qualitatively." *(Interviewee 1, Chemical Engineering Program)*

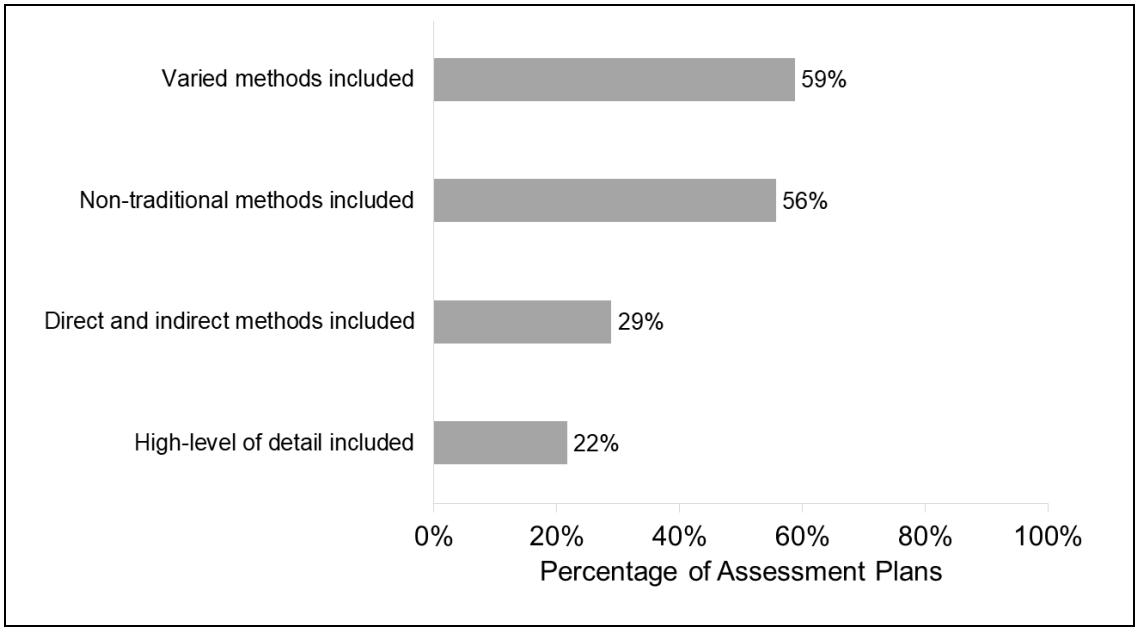

Figure 4-3: Percentage of assessment plans according to the type and number of assessment methods included (a total number of 97 assessment plans was analysed according to the coding scheme in https://bit.ly/37UjxdF)

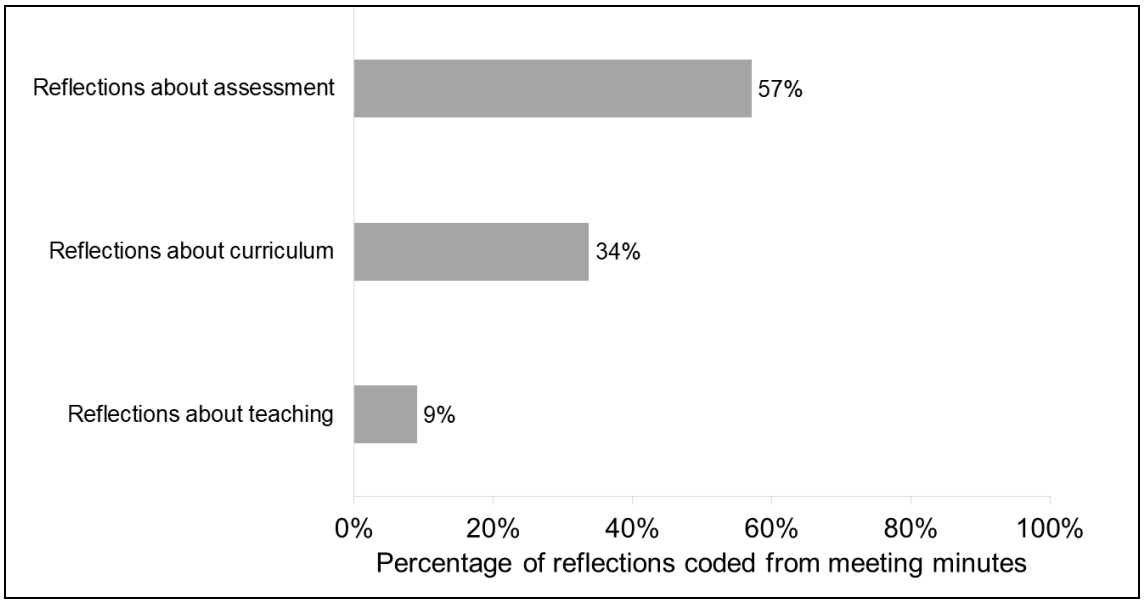

Figure 4-4: Percentage of reflections coded from 27 meeting minutes (a total number of 85 reflections were coded according to the coding scheme in https://bit.ly/2Vc5vit)

Besides, finding 3.3 indicates that teaching staff's engagement with continuous curriculum improvement is particularly enhanced when teaching staff receive support for their teaching practices. On the one hand, 56% of teaching staff members included non-traditional assessment methods (see 'non-traditional methods included' in Figure 4-3), such as course projects and oral presentations, as it was intended in the workshops imparted to support the planning of student outcomes assessment at a course-level. On the other hand, about a fifth part of the reflections that were coded in the meeting minutes of curriculum discussions where related to the further need for support from their teaching assistants (see 'reflections about curriculum' in Figure 4-4). Along these lines, the following quotes were extracted from the meeting minutes:

"However, in operational terms, it is recommendable that teaching assistants know from the beginning that they will work throughout the semester in a process for continuous quality improvement. It is highly recommended to make teaching assistants participate in the process." *(Meeting minute, Computer Engineering Program, first semester of 2016)*

"Nonetheless, the program asked a representative of the Engineering Education Unit to involve teaching assistants in the assessment process." *(Meeting minute, Electrical Engineering Program, first semester of 2016)*

As a response to this situation, the Engineering Education unit started involving teaching assistants in the continuous improvement process since the second semester of 2016, which implied an increase in the level of teaching staff engagement with outcome assessment tasks — as it is shown in Figure 4-2. According to the coding results of semi-structured interviews, most teaching staff valued teaching assistants' time and understanding of how students experience teacher's actions:

"It is a very good sign to count on the teaching assistants, that is, if there is an additional payment for them, they can dedicate some extra hours to support us... and it feels more internal compared to support from the Engineering Education Unit. Of course, the unit could come and help you at the beginning, but daily (...) it is your teaching assistant who you could ask for help." *(Interviewee 7, Civil Engineering Degree)*

"Their (teaching assistants') contribution is fundamental because (...) they have another perspective on how to get to know the reality of the student and make it closer to the teacher, (…) they are the main grounding wire that we have, the permanent contact with the student." *(Interviewee 9, Mechanical Engineering Program)*

Along with the engagement mechanisms, we also found disengagement mechanisms that discouraged teaching staff from undertaking outcome assessment tasks or participating in curriculum discussions. Finding 4.3 indicates that teaching staff disengaged when they perceived that institutional policies were misaligned, because they felt forced to respond to contradictory logics. During interviews, staff mentioned that the evidence they collected for the continuous improvement process was not considered in the faculty promotion process, so their efforts to align course methods with program outcomes did not account for the quality of their teaching but simplified quantifiable metrics did (such as the results of end-of-course surveys). They also mentioned that the continuous improvement process overemphasized the use of student grading as learning results, disregarding other types of formative assessments that might be better aligned to the student outcome assigned. This might explain why only 29% of assessment plans included both direct and indirect assessment methods (see 'direct and indirect methods included' in Figure 4-3).

Concerning the disengagement mechanisms, Figure 4-2 shows that teaching staff invested less efforts in outcome assessment tasks during the first half of 2016, when managers requested them to prepare a report for ABET accreditation. According to finding 4, this is explained by the fact that the teaching staff disengaged when managers emphasized that their main purpose was to respond to external demands (i.e. ABET standards), rather than responding to the internal need to improve student outcome attainment. According to the coding results of semi-structured interviews, teaching staff perceived a lack of clarity and transparency regarding leadership priorities:

"In this last accreditation, it appears that we really had to measure the student outcomes from A to K (…), because ABET said, 'Yes (…), we want the student outcome separately measured at best at a course level.' One thing is the achievement of the global objectives of the course — which is the final grade, but another thing is to ensure outcome attainment separately." *(Interviewee 3, Computer Engineering Program)*

"The senior managers used this idea of 'it is because it is ABET.' Of course, ABET is a powerful external force. Then, the argument is 'ABET says it, so it has to be done.' No further arguments, and that is hard; it is hard to digest." *(Interviewee 7, Civil Engineering Program)*

Considering that some mechanisms predominated over others during the process, teaching staff suggested to unify all efforts to continuously improve the curriculum in one process, focusing this process mainly on outcome assessment and curriculum decision-making.

"If they make me to follow-up two processes, three processes, (…) you start losing the thread and one day you ask yourself, 'What are we monitoring? Are we monitoring ABET student outcomes? Our curriculum?' Then, we would expect a single process, where somehow everything is together, despite specific differences in the accreditations or other processes." *(Interviewee 4, Electrical Engineering Program)*

"I think it would be ideal to have an autonomous mechanism, made in UC-Engineering; our continuous improvement process, independent of ABET and the national accreditation. That is, a macro system that (...) when we ask for a report for ABET, or for the national accreditation, it consists in just a query in a database, having only one system to assess student outcomes." *(Interviewee 9, Mechanical Engineering Program)*

Further considerations to redesign the continuous improvement processes emerged from semi-structured interviews. First, the process should acknowledge efforts that teaching staff are already investing to improve their courses. Second, the process should involve teaching assistants in outcome assessment tasks, in order to connect learning results with the reality of each student. Third, curriculum discussions should be held in program meetings to increase the number of opportunities to reflect about teaching practices at a program level. Finally, they suggested to leverage existing faculty practices (e.g. program meeting and faculty luncheons) to create a shared sense of the process, besides using the evidence collected to complement student evaluations of teaching.

4.6. Discussion and limitations

This case study expands the current understanding of teaching staff's engagement with continuous curriculum improvement by illustrating the role of specific mechanisms in a real-world university setting. By analysing a continuous improvement process for a long period of time, we could observe that engagement and disengagement mechanisms coexisted throughout the process. As a consequence, teaching staff exhibited varying levels of engagement, which contradicts the belief that staff are set in their ways and sceptical about outcome assessment tasks (Schoepp & Tezcan-unal, 2017; Swarat et al., 2017). On the contrary, finding 3.1 shows that most of the teaching staff feel accountable for student learning, which motivates them to use varied assessment methods to measure student outcome attainment, in order to use this evidence to reflect about the effectiveness of their teaching practices (Bouwma-Gearhart & Hora, 2016; Schoepp & Tezcan-unal, 2017). According to finding 3.2, this intrinsic motivation to use evidence to improve their teaching is particularly enhanced when they receive support for their teaching practices. Prior work has described extrinsic triggers (Bendermacher et al., 2017), such as grants to educational projects and teacher prizes, but providing staff with time and resources to reflect about their teaching can be even more powerful to support curriculum change (Barradell et al., 2017; Hora, 2016).

Nevertheless, this case study also confirms the existence of tensions between staff and managers over assurance of learning. So far, higher education literature has mainly documented tensions due to managerial practices for assessing student outcome attainment (Bendermacher et al., 2017; Brady & Bates, 2016; Vican et al., 2020). However, few studies describe stakeholders' perspectives on how to overcome these tensions and actually focus on improving the quality of teaching and learning (Bendermacher et al., 2017; Busco et al., 2018; Matthews & Mercer-Mapstone, 2018). In order to shed light on this issue, finding 3.3 explains that these tensions are due to the misalignment of institutional policies that introduce contradictory logics (i.e. improving teaching versus reducing teaching to a simplified quantifiable metric). Besides, finding 3.4 portrays the tension between internal and external perspectives on continuous curriculum improvement (i.e., teaching staff perspectives on improving the quality of teaching and learning versus external demands of ABET accreditation criteria respectively).

Still, case study findings show that these tensions do not necessarily imply a barrier to implementing continuous improvement efforts. Furthermore, this case study provides practical suggestions for other higher education leaders who are interested in implementing continuous improvement processes at their institutions. These suggestions emerged from semi-structured interviews with teaching staff who participated in the continuous improvement process under study:

1. Focus data collection efforts on improving teaching and learning (obtaining evidence for external stakeholders as a sub-product of these efforts).
2. Provide faculty development and support (allowing students to collaborate with teaching staff in outcome assessment tasks and curriculum decisions).
3. Align institutional policies to create shared understanding of continuous curriculum improvement (acknowledging efforts that teaching staff already invest to improve their teaching in faculty evaluations).
4. Increase reflection opportunities for curriculum discussions and teaching staff collaboration (leveraging existing faculty practices, such as faculty luncheons and program meetings).

These suggestions resonate with considerations that have been previously described in the literature on change management in higher education. Specifically, these suggestions are aligned with the mechanisms proposed by Bendermacher et al. (2017), revealing the importance of both organizational processes and cultural elements for continuous curriculum improvement. The first suggestion reinforces the mechanisms of shared ownership by reinforcing teaching and learning identities throughout data collection (see 'shared ownership' in Figure 4-5). The second suggestion expands the definition of empowerment by revealing the importance of acknowledging efforts that staff already invest to improve their teaching in faculty evaluations (see 'empowerment' in Figure 4-5), The third suggestion strengthens knowledge by increasing reflection opportunities for curriculum discussions and teaching staff collaboration (see 'knowledge' in Figure 4-5). Finally, the fourth suggestion highlights the importance of commitment to improve teaching at an institutional level by providing faculty development and support (see 'commitment' in Figure 4-5). Therefore, this case study contributes to the existing literature by providing empirical evidence about the enactment of mechanisms for a quality culture in other higher education institutions.

For dealing with the tensions between institutional managers and teaching staff, case study participants suggest to incorporate all these engagement mechanisms into a single process. By effectively engaging teaching staff members in outcome assessment tasks and curriculum discussions, these mechanisms should enable managers to collect evidence to comply with external accountability demands (such as ABET accreditation). This implies giving greater importance to the role that teaching staff members play as the planners and enactors of curriculum elements that could lead to better learning outcomes (Roberts, 2015), without disregarding the role that managers play through their abilities to influence resource allocation and role distribution (Bendermacher et al., 2017; Bouwma-Gearhart & Hora, 2016). To summarize, continuous improvement tasks should support teaching staff efforts to effectively improve learning results first, so that managers can then use those results to comply with external demands later.

Faculty engagement in continuous curriculum improvement is crucial to create a quality culture that enhances teaching and learning and must not be disregarded (Bouwma-Gearhart & Hora, 2016; Hora, 2016; Matthews & Mercer-Mapstone, 2018). In these lines, leaders and managers can follow the practical suggestions that emerged from this case study to go beyond accreditation compliance, and actually improve teaching and learning practices at a program level. Still, these suggestions are subject to cultural biases and generalization issues that affect the interpretation of findings of single-case studies. In this study, researchers with different backgrounds were involved in the case study analysis to avoid interpreting and judging findings by standards inherent to one culture. Besides, findings were analysed in the light of prior literature in higher education. Still, future work should focus on illustrating how engagement mechanisms reinforce their teaching identity of faculty members, providing further empirical evidence to inform the design and implementation of continuous curriculum improvement in other institutions.

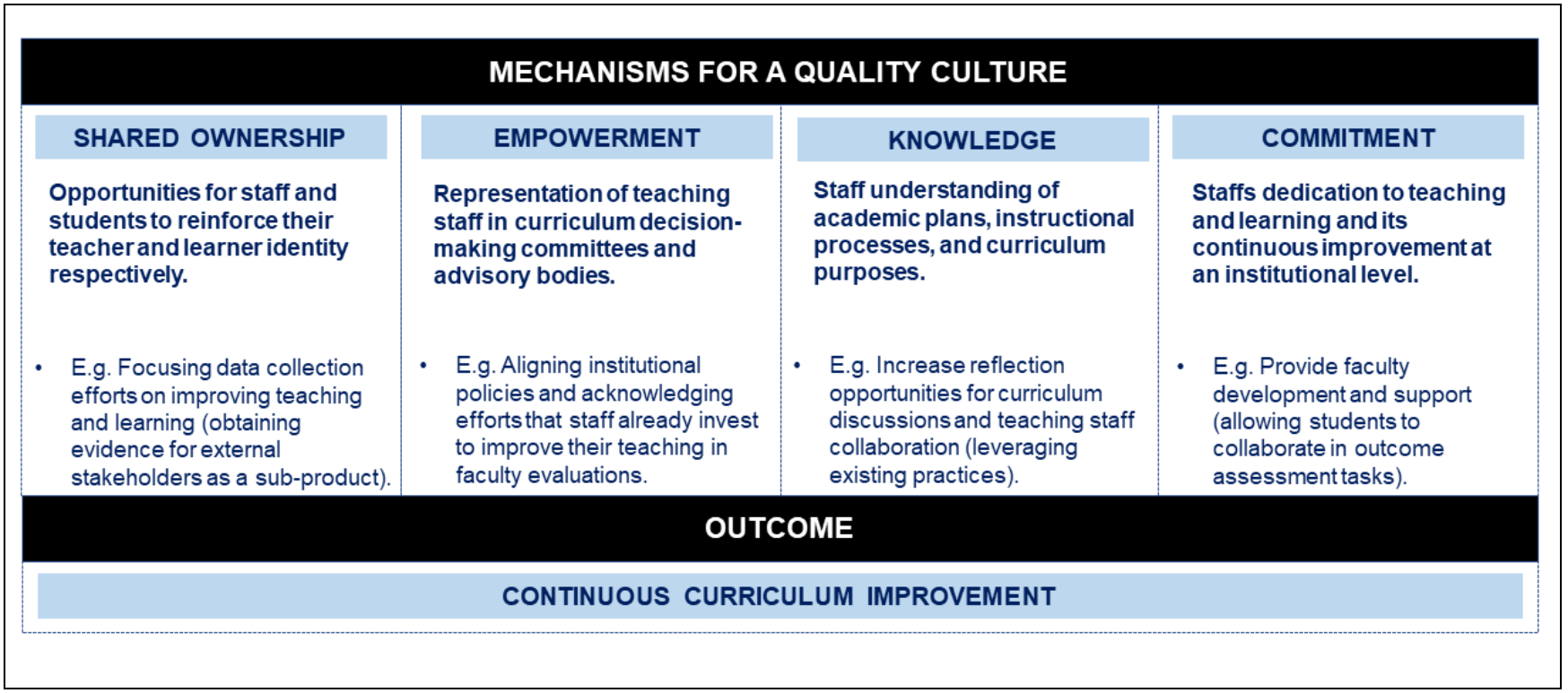

Figure 4-5: Relationship between the mechanisms for a quality culture described by Bendermacher et al. (2017) and the practical suggestions that emerged from the case study

5. CONCLUSIONS

5.1. Summary of findings

Table 5-1 summarizes the findings of this thesis regarding the needs for LA adoption and the lessons learned from exploring tools and mechanisms to promote continuous curriculum improvement. These findings are based on the collection and analysis of qualitative and quantitative information in Latin American universities by means of different applications of mixed methods (see details in sections 1.4, 2.4, 3.2, and 4.4). For further generalization of these findings, we contrasted them with prior literature on learning analytics and quality enhancement in higher education.

Table 5-1: Summary of findings of this thesis

Research questions	Findings
1. What are the needs for LA adoption in Latin American universities from the perspective of their stakeholders (students, teaching staff, and managers)?	1.1. Students need quality feedback and data-driven support from teaching staff to improve their learning results. 1.2. Students need timely support interventions from staff and managers when they are facing difficulties that affect their academic performance. 1.3. Teaching staff need timely alerts from managers to provide better support to students who are facing difficulties that affect their academic performance. 1.4. Teaching staff need meaningful and 'easy-to-use' feedback about their performance and the quality of their teaching to inform their practice. 1.5 Managers need quality information from staff to evaluate support interventions targeted at students.
2. How does a curriculum analytics tool impact continuous curriculum improvement in higher education settings?	2.1. Managers and teaching staff emerged as the primary personas of a CA tool, whereas current and future students emerged as secondary personas. 2.2. The first version of the CA tool helped teaching staff to collect a greater number and variety of documentary evidence regarding competency attainment. 2.3. Usability and functionality issues prevented teaching staff from using the CA tool to obtain information to redesign courses and to reflect about students' performance. 2.4. Managers and teaching staff perceived that the improved version of the CA tool is useful for assuring program quality and student learning at a course-level.

Research questions	Findings
	2.5. The improved version of the CA tool was considered user-friendly and easy to use according to the subject groups who participated in the field study.
3. How do mechanisms engage and disengage teaching staff in a higher education institution with continuous curriculum improvement?	3.1. Teaching staff engage with continuous improvement tasks when data collection is focused on improving teaching and learning at different levels. 3.2. Teaching staff engage with continuous improvement tasks when they receive support for their teaching practices. 3.3. Teaching staff disengage with continuous improvement tasks when institutional policies are misaligned, forcing them to respond to contradictory logics. 3.4. Teaching staff disengage with continuous improvement tasks when their main purpose is to respond to external demands.

In order to identify needs for LA adoption in Latin American universities, this thesis presents findings obtained from triangulating qualitative and quantitative information collected from students, teaching staff, and managers to answer **research sub-question 1** (see findings 1.1 to 1.4 in Table 5-1). Not only do findings reveal students' need for quality feedback and data-driven support interventions, but also staff's need for quality and 'easy-to-use' information to anticipate students' needs — particularly of those students who are facing difficulties that affect their learning process. So far, researchers have proposed LA solutions to meet these needs separately. On the one hand, there are LA dashboards to provide students with feedback about their learning results, encouraging them to demonstrate help-seeking behaviours (Bodily & Verbert, 2017; Jivet et al., 2018). On the other hand, there are LA solutions that integrate different sources of data, providing managers and teaching staff with indicators regarding student demographics and academic performance (B. T. M. Wong, 2017). This means that the needs identified in this thesis could be met by adapting existing LA dashboards and solutions to Latin American contexts, raising awareness of the potential benefits of learning analytics amongst policy- and decision-makers within the region. *Then, this thesis confirms the importance of identifying stakeholders' needs prior to the design and implementation of LA tools and policies* (Gašević, 2018), *using the needs assessment as an*

intervention itself to generate expectations for the adoption of existing LA services to drive continuous improvement at an institutional level (Ortiz-Rojas et al., 2019).

The recent emergence of curriculum analytics as a sub-field of LA creates an opportunity to meet the needs of both students and staff in a single strategy. Curriculum analytics tools integrate program- and course-level data to know what courses students are taking throughout different academic periods (M. Brown et al., 2018; Heileman et al., 2017), in addition to monitoring student outcome attainment at different levels (Chou et al., 2015). By using a curriculum analytics tool, managers would have information to evaluate when a support intervention is needed in a subset of courses, so they could timely alert teaching staff members if a particular subgroup of students needs feedback on their learning results. Besides, teaching staff would also have readily available information about student outcome attainment, so they could evaluate the effectiveness of their teaching practices based on students' learning. Then, satisfying students' need for quality feedback and data-driven support would not only be subject to their interpretation of LA dashboards or their help-seeking behaviour, but also to the capacity of managers and teaching staff to anticipate the need for support interventions based on visualizations of course- and program-level indicators. This is particularly relevant in Latin America and other regions where most of the new higher education students come from middle and low-income segments (Ferreyra et al., 2017), without necessarily having support from a role model or having developed help-seeking skills (Cobo & Aguerrebere, 2018).

Concerning curriculum analytics, this thesis documents different lessons learned from having designed and implemented a curriculum analytics tool to answer **research sub-question 2** (see findings 2.1 to 2.5 in Table 5-1). According to these lessons learned, managers and teaching staff emerged as primary users of this type of tools, because they are the ones responsible for assuring program quality and student learning. However, this does not mean diverting attention from the needs of students, but helping staff to make informed decisions about curriculum elements that influence student learning (Ochoa, 2016), such as instructional resources and evaluation (Lattuca & Stark, 2009). Along these lines, findings show that a curriculum analytics tool could help staff to collect a greater number and variety of

evidence regarding the assessment and attainment of competencies, enabling them to reflect about curriculum and teaching practices. In order to ensure that staff benefit from this type of tools, findings indicate that it is important to address usability and functionality issues that could prevent staff from using them to reflect about students' performance. *Then, this thesis reveals the importance of engaging stakeholders throughout the development of curriculum analytics tools (Tsai et al., 2018); so that they not only have influence over the design process, but also become aware of its capabilities and limitations ahead of implementation* (Greer, Molinaro, et al., 2016).

For understanding how to engage teaching staff with continuous curriculum improvement, this thesis presents findings obtained from a case study developed to answer **research sub-question 3** (see findings 3.1 to 3.4 in Table 5-1). These findings reveal the importance of focusing outcome assessment efforts on making sense of the curriculum experience, engaging teaching staff in reflections on how to improve teaching and learning. Findings also reveal the importance of providing staff with support for their teaching practices, helping them to assess student outcomes in a meaningful way. Although there are tensions between stakeholders regarding the assessment of student learning and the assurance of program quality (Bendermacher et al., 2017; Brady & Bates, 2016; Vican et al., 2020), these tensions do not represent a barrier to implement processes for continuous curriculum improvement. On the contrary, these tensions create an opportunity to generate shared understanding of continuous curriculum improvement, using analytical tools to promote a quality culture among stakeholders. This means that teaching staff genuinely perceive managers and students as partners for continuous curriculum improvement, valuing students' feedback on how to improve student outcome attainment (Bunce et al., 2017), or their collaboration with teaching and learning activities — such as tutoring and the development of instructional resources (Seale, 2016). *Then, this thesis reveals that the benefits of using analytical tools are subject to the implementation of engagement mechanisms for a quality culture* (Gašević, 2018), *so teaching staff are encouraged to use these tools to regularly evaluate the effectiveness of curriculum elements in terms of student outcome attainment (Matthews & Mercer-Mapstone, 2018).*

Along with implementing engagement mechanisms, it is important to align internal and external policies that affect teaching staff engagement with continuous curriculum improvement. By internal and external policies, we mean regulations such as faculty evaluations and national or international accreditations. In Latin America, governments have implemented quality assurance policies over the past two decades, aiming to reinforce minimum standards for higher education programs, such as faculty qualifications, curriculum criteria, and infrastructure regulations (Bernasconi & Celis, 2017; Ferreyra et al., 2017). These policies have promoted practices such as self-assessment, which have had a positive impact on organizational learning and cultural change (Busco et al., 2018). However, it is necessary to prioritize the needs of internal stakeholders over external demands, particularly if the aim is to impact student learning (Matthews & Mercer-Mapstone, 2018). *According to the findings of this thesis, this work does not mean ceasing to comply with external demands for accountability, but rather redirecting these efforts to assess both stakeholders' needs and student outcome attainment throughout a systematic and iterative process. Then, curriculum analytics tools could be used to provide internal stakeholders with evidence about student learning that is relevant to renew curriculum strategies*.

5.2. Implications for practice

All the findings presented in this thesis represent a contribution to higher education practice and research. First, the answer to **research sub-question 1 (RQ1)** provides an in-depth analysis of the needs for LA adoption in Latin America, opening a window of opportunity to integrate LA solutions to address persisting educational challenges (Cobo & Aguerrebere, 2018; Maldonado-Mahauad et al., 2018). Second, the answer to **research sub-question 2 (RQ2)** describes a set of lessons learned from having designed and evaluated a curriculum analytics tool, contributing to expanding local capacity to adapt and adopt this type of tools to improve academic decision-making processes. Finally, the answer to **research sub-question 3 (RQ3)** presents a case study about a 3-year continuous improvement process that was implemented in a large and selective university in Chile, contributing to understanding teaching staff engagement with outcome assessment tasks and curriculum decision-making.

In addition to the contributions for each of the research questions separately, further contributions could be extrapolated from integrating all findings to answer the general research question: *How to promote continuous curriculum improvement in higher education programs in Latin America using Learning Analytics?* For this integration, we followed the approach proposed by O'Cathain, Murphy, and Nicholl (2010), who claimed that the interaction among findings could provide researchers with more knowledge than a separate analysis. Specifically, we analysed the interaction among the findings to answer each research question (see Table 5-1), aiming to identify key aspects to promote continuous curriculum improvement in higher education settings. As a result, we obtained a framework that highlights the importance of identifying stakeholders' needs, along with the designing and implementing curriculum analytics tools and engagement mechanisms to renew curriculum strategies and improve student outcome attainment. Figure 5-1 presents the framework that was obtained from the integration of the findings of this thesis.

The proposed framework is composed of three main aspects that need to be considered when promoting continuous curriculum improvement in higher education institutions: 1) stakeholders' needs, 2) curriculum analytics, and 3) engagement mechanisms. These three key aspects are interrelated in a square, representing the structural/managerial aspects that a direct impact on all stakeholders: managers, teaching staff, and students. Within this structure, teaching staff play an intermediary role between managers and students. On the one hand, teaching staff are responsible for undertaking outcome assessment tasks, enabling managers to collect evidence to comply with external accreditation demands. On the other hand, this framework also acknowledges that teaching staff are responsible for planning and enacting curriculum elements (such as instructional resources and assessment methods), influencing students' learning process and outcome attainment. However, cultural/psychological elements are also key aspects of promoting continuous curriculum improvement (Bendermacher et al., 2017). In order to acknowledge internal stakeholders' influence over continuous curriculum improvement, we positioned them in the top-half of the square to indicate that they are the ones who drive any continuous curriculum improvement initiative.

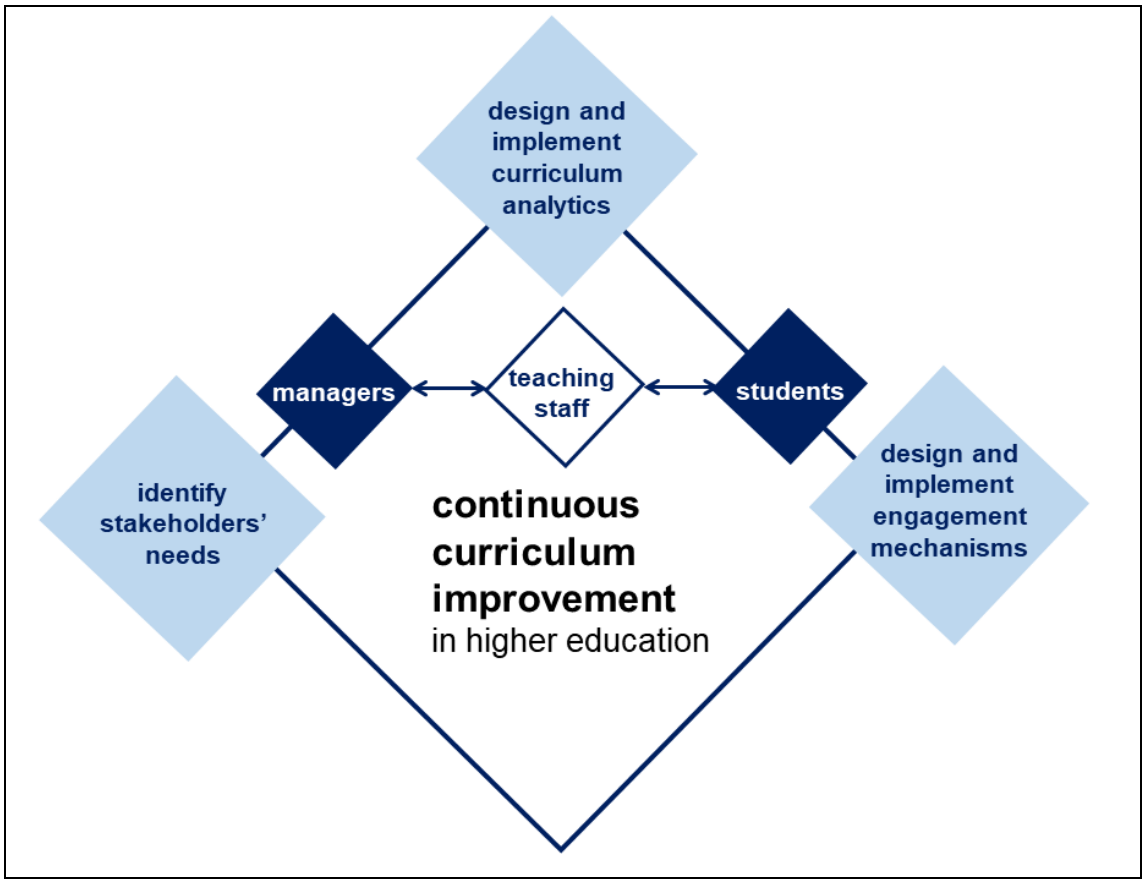

Figure 5-1: Framework for promoting continuous curriculum improvement in higher education programs.

Regarding stakeholders' needs, this thesis confirmed the importance of identifying them to generate a shared understanding of continuous curriculum improvement among managers, teaching staff, and students. This is why the framework highlights the importance of identifying stakeholders' when implementing an initiative of continuous curriculum improvement. Concerning curriculum analytics, this framework proposes the implementation or adaptation of curriculum analytics tools to meet the needs of all stakeholders in a single strategy. According to the findings of this thesis, managers and teaching staff are the primary users of this type of tools, but students also benefit from their use to renew curriculum strategies. Finally, regarding the engagement mechanisms, this thesis stresses the importance of designing and implementing engagement mechanisms to sustain a curriculum improvement initiative. These mechanisms should not only motivate teaching staff to regularly

collect and analyse evidence of student outcome attainment by using curriculum analytics tools, but also motivate them to use them regularly to reflect about the effectiveness of their curriculum and teaching practices in terms of learning results. Along these lines, the findings of this thesis indicate that teaching staff engagement is crucial for continuous curriculum improvement, so that outcome assessment tasks and curriculum discussions actually lead to an improvement of student learning and program quality.

There are two ways to use the framework presented in Figure 5-1. The first way is to use it as a conceptual framework that serves as a starting point to promote continuous curriculum improvement in higher education settings (see Figure 5-2). This means interpreting the needs detected in this thesis as one's own, and start incorporating learning analytics tools and engagement mechanisms to promote continuous curriculum improvement in their institutions. This implies undertaking the following tasks:

- To identify stakeholders' needs:
    - Identify existing institutional processes to support and deliver feedback to students.
    - Identify relevant indicators to evaluate the need for support interventions and the quality of teaching practices.
- To design and implement curriculum analytics:
    - Identify an institutional process that could benefit from using a curriculum analytics tool.
    - Explore how educational data is gathered and currently used as evidence for curricular and instructional change.
    - Engage managers and teaching staff throughout tool development phases, in order to address usability and functionality issues.
- To design and implement engagement mechanisms:
    - Increase opportunities to reflect on student learning and outcome attainment in existing program meetings and committees.
    - Offer support to teaching staff to align course teaching and assessment methods with course learning outcomes (allowing students to collaborate with teaching staff in outcome assessment and curriculum discussions).

- Align policies to acknowledge teachers' engagement in continuous improvement tasks (such as faculty evaluations and accreditations).

Considering that this thesis collected data in five Latin American universities, this approach is particularly valuable for institutions in this region that have the urgent need to improve program quality and student retention (Ferreyra et al., 2017).

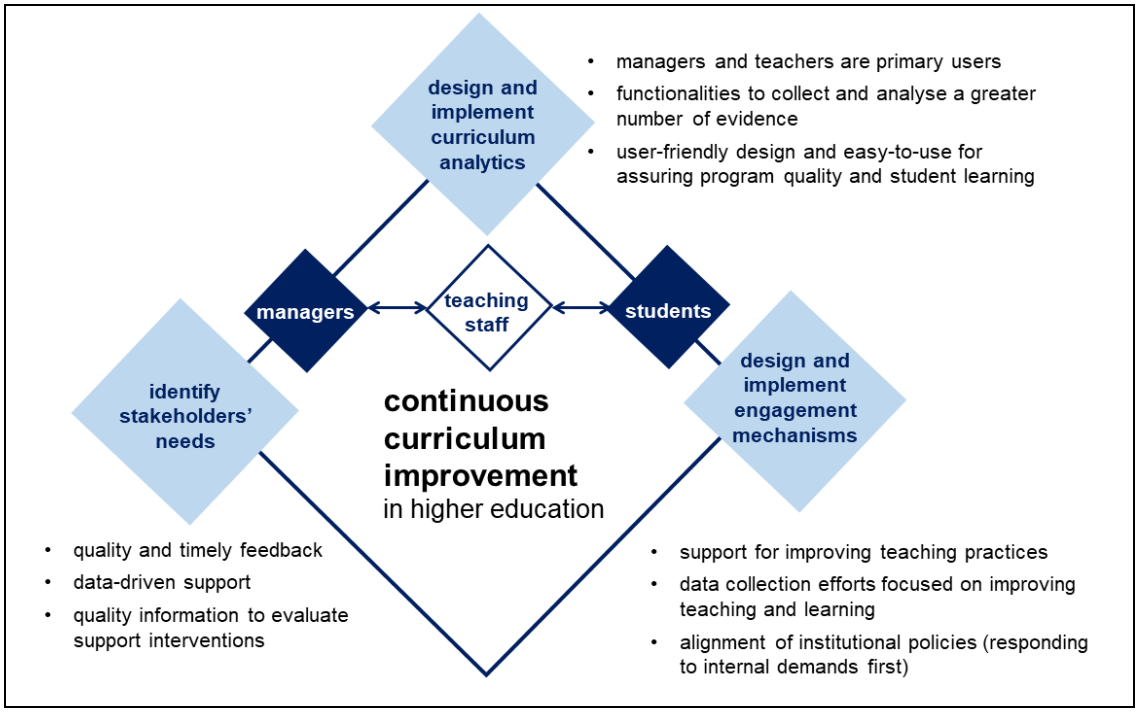

Figure 5-2: Conceptual framework to promote continuous curriculum improvement in higher education

The second way is to use this framework as a methodological approach. This means adopting or adapting the instruments that were used throughout this thesis in order to the efforts to identify stakeholders' needs, and to design and implement curriculum analytics tools and mechanisms to engage teaching staff with continuous curriculum improvement. Figure 5-3 describes this methodological framework, which implies undertaking the following tasks:

- To identify stakeholders' needs:
    - Conduct individual semi-structured interviews with managers and focus groups with students and teaching staff to collect information

about the current and the desired use of educational data in their institutions (see Appendix A).

    - Apply questionnaires to students and teaching staff to collect information about the expectations of these stakeholders regarding the adoption of learning analytics services at an institutional level (see Appendix B).

- To design and implement curriculum analytics:
    - Follow a design-based research approach to design and evaluate a curriculum analytics tool throughout an iterative process:
        - Start by developing an instrumental case study to evaluate the use of curriculum analytics before and after tool implementation (see Appendix C)
        - Conduct a field study to evaluate the use of curriculum analytics from the perspective of different users affiliated with different institutions (see Appendix D)
- To design and implement engagement mechanisms:
    - Develop a single case study to understand teaching staff engagement with a continuous improvement process (see Appendix E):
        - Analyse documentary evidence collected from outcome assessment tasks and curriculum discussions
        - Conduct semi structured interviews with program chairs and teaching staff

This methodological approach is particularly valuable for higher education institutions that are interested in gathering more focused information on the context and the dynamics among managers, teaching staff, and students. In these lines, this thesis provides basic guidance on how to identify relevant sources of information (e.g. documentary evidence), along with providing protocols to effectively gather information from internal stakeholders (e.g. semi-structured interviews, focus groups, questionnaires). Additionally, each one of the Appendices of this thesis provide more specific guidelines about collecting and analysing information to address each one of the aspects highlighted in the framework.

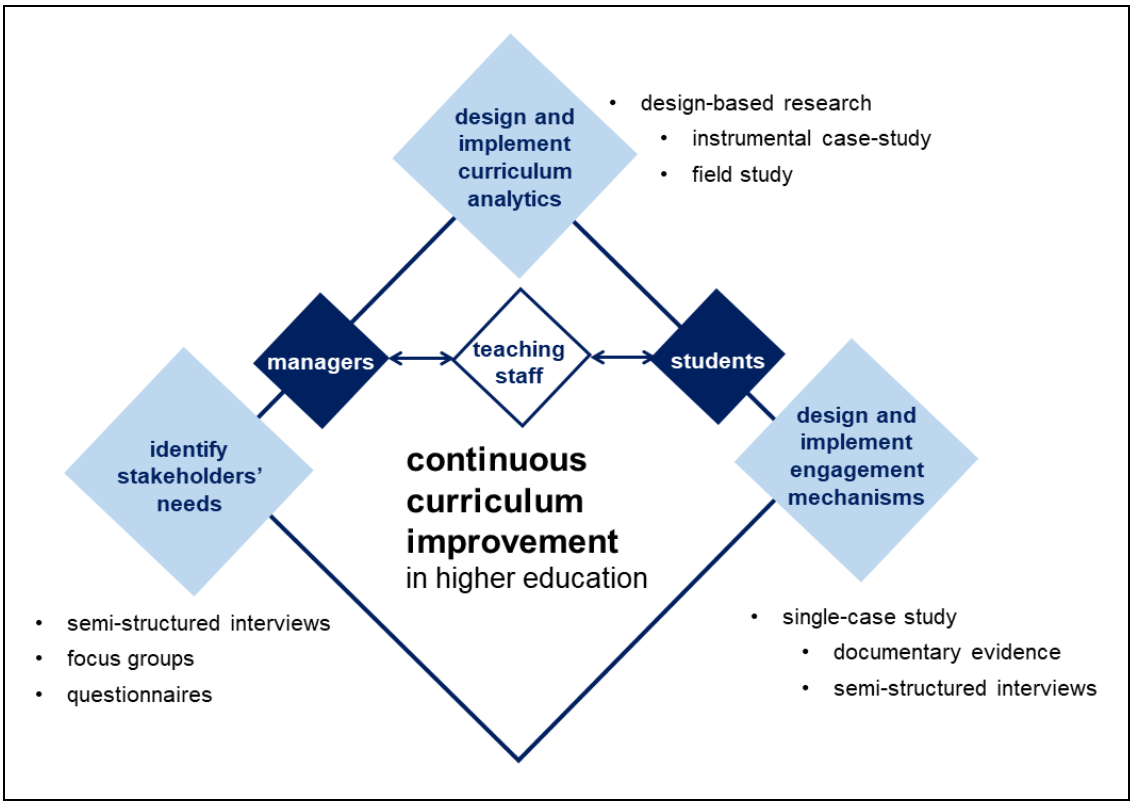

Figure 5-3: Methodological framework to promote continuous curriculum improvement in higher education

In that sense, this thesis enables higher education practitioners and researchers to build upon this framework by using its findings or its data gathering techniques as a basis for promoting continuous curriculum improvement in different higher education settings. Along these lines, we recommend these actors to engage stakeholders in a dialogical approach to increase their awareness about the importance of continuous curriculum improvement and the existence of LA services, while the ability to design or adapt curriculum analytics tools for improving student-learning experiences grows in their institutions.

5.3. Limitations

As with the majority of studies, this thesis is subject to limitations. The first limitation is associated to the fact that this thesis builds upon growing fields of academic research. On the one hand, this thesis promotes continuous curriculum

improvement towards a quality culture, and the research about quality culture eleents is still at an emerging stage (Bendermacher et al., 2017). On the other hand, this thesis proposes using learning analytics to promote continuous curriculum improvement in diverse higher education settings, and learning analytics is a research field that has recently emerged from other research fields (Siemens & Gasevic, 2012; Viberg et al., 2018), such as technology-enhanced learning and learning theories. Although researchers have highlighted the rapid maturation of this research domain in some regions, such as Europe and North America, it is still considered an emergent field in developing regions, such as Latin America (Cobo & Aguerrebere, 2018). Consequently, there is a lack of previous studies to contrast the findings of this thesis.

The second limitation is due to time constraints inherent to the doctorate studies. During these four years, we were able to witness the formulation of improvement actions in some of the engineering programs offered at PUC-Chile, in addition to observing a higher appreciation of the efforts invested to assess student outcome attainment and to discuss the need for further renewal of curriculum elements. However, these four years were not enough to quantify the impact of these changes, nor to anticipate further changes that might appear due to the adoption of learning analytics. So far, few studies have managed to provide evidence about the institution-wide deployment of these type of tools, and about the effects of this deployment on learning outcomes (Viberg et al., 2018). With respects to the adoption of the curriculum analytics tool that was evaluated in this thesis, further longitudinal effects might be obtained from its use to improve program quality and student learning. Therefore, there are results that are not observable during the research timeline.

Finally, there are limits to generalize findings. Throughout the thesis, data was collected in five Latin American universities. These universities are relevant to this region as benchmarks for program quality and research generation (Knobel & Bernasconi, 2017), but do not necessarily represent the wide diversity of higher education institutions in Latin America and other regions. The contexts in which learning occurs are highly variable, making it difficult to develop generalizable research in fields such as education and LA (Ferguson & Clow, 2017). In order to

address these generalization issues, future replication studies could be derived from this thesis.

5.4. Future work

Replication is a core principle of the scientific method, and it enables extensions that could be novel and valuable contributions to any body of knowledge, including technology enhanced learning and higher education (Ahadi et al., 2016). This is why this thesis proposes a methodological approach to help higher education institutions from different contexts to follow the framework obtained from the integration of its findings (see Figure 5-3). In that sense, future work should focus on replication studies to evaluate the extension of findings, besides exploring further themes related to institutional adoption of LA services and curriculum analytics tools, in addition to mechanisms to promote continuous curriculum improvement during and after COVID-19.

5.4.1. Institutional adoption of learning analytics tools

In Latin America, higher education systems have the urgent need to reduce program quality disparities and dropout rates (Ferreyra et al., 2017). Considering that the stagnant culture which has existed in higher education systems in this region has not solved these educational challenges (Knobel & Bernasconi, 2017), LA adoption is perceived as a promising opportunity to start a slow and incremental process with long lasting beneficial effects in terms of learning outcomes (Cobo & Aguerrebere, 2018). From the perspective of the higher education stakeholders who were involved in this thesis, there are opportunities to integrate LA services into existing data practices, such as academic counselling and course planning (Hilliger et al., 2020). In order to better understand implications and mechanisms of adopting LA tools in varied contexts, more research is required to analyse different LA services in Latin American universities. By sharing tool deployment experiences, institutional leaders might be able to see the whole picture regarding the implications of integrating LA into higher education practices of their stakeholders.

Researchers have also revealed the need for more studies to explore whether LA services and curriculum analytics are used wisely and deploy a scale, and if their use leads to the improvement of student learning and program completion (Ferguson & Clow, 2017; Viberg et al., 2018). Although this thesis was an intervention itself to generate expectations for the institutional adoption of curriculum analytics tools, future studies should evaluate if the adoption of the CA tool that was developed in this thesis actually leads to improvements in student outcome attainment. In this context, future work should focus on needs assessment and stakeholder engagement for institutional adoption of analytical solutions, along with more robust design-based research to evaluate the use and impact of curriculum analytics tools.

Finally, it is also important to explore if LA services and curriculum analytics tools are used in an ethical way (Ferguson & Clow, 2017; Viberg et al., 2018). In Latin America, prior work has revealed the need to develop policies to regulate the ethical use of educational data (Beardsley et al., 2019; Hilliger et al., 2020). Along these lines, this thesis proposes considerations to promote continuous curriculum improvement using curriculum analytics, which could also inform regional actions for institutional adoption of LA services. Still, more work is required to install valid and reliable systems to integrate course- and program-level data, ensure informed consent for its use, and promote data transparency — informing stakeholders who has access to their data and for what purpose (Beardsley et al., 2019). Besides, further regulations and codes of practice are needed to design and implement data protection policies, taking into consideration the Brazilian General Data Protection Law enacted in 2018, the amendment of the Chilean Data Protection Law (adopted also in 2018), and the European General Protection Regulations (Villan, 2019), among further ethical guidelines (Pérez-Sanagustín et al., 2018).

5.4.2. Continuous curriculum improvement during COVID-19

Practical suggestions have emerged from this thesis to support continuous curriculum improvement in higher education programs in Latin America and other regions. One of these suggestions is to align internal and external policies into a single process to monitor and improve student outcome attainment at a program level. Along this

process, higher education stakeholders should work as partners, particularly teaching staff and students. Although teaching staff and students have started to become more involved in curriculum discussions and program committees, few studies have explored how teaching staff and students collaborate in the definition of curriculum elements, such as instructional resources and evaluation. It is crucial to understand the reality of each student to help them meet the expected learning outcomes. Therefore, future work should focus on generating a shared understanding of continuous curriculum improvement among stakeholders, along with exploring mechanisms that reinforce students' learner identity during curriculum decision-making.

Furthermore, this type of studies about continuous curriculum improvement are particularly relevant in the current context. Higher education is one of the sectors that has not stopped despite the devastating nature of the pandemic caused by COVID-19 (Suarez, 2020), but still has been deeply affected with the spread of COVID-19 across the world (Crawford et al., 2020). Countries in Asia, Europe, Africa, the Middle East, North America, and Latin America have announced or implemented university closures (UNESCO, 2020), and most of these universities have implemented 'emergency online education'. By 'emergency online education', researchers mean millions of faculty members teaching in front of computer screens, and millions of students staying at home and taking their courses through internet (Bao, 2020). In Latin America and Caribbean countries, more than 28 million university students are now learning in a remote environment (Suarez, 2020).

As a consequence of this rapid transition to online education, the pandemic has both revealed and exacerbated quality and equity issues. While students from more privileged backgrounds retain many advantages to succeed, students from less privileged backgrounds might not have access to advantages of residential education — such as tutoring and counselling (Maloney & Kim, 2020). Besides, socially disadvantaged students have limited access to technology and the internet, facing problems to engage with teaching and learning activities in an online environment (Crawford et al., 2020). These consequences of the pandemic have affected Latin America more than other regions, because of the lack of digital skills in faculty

members and the lack of resources at an institutional level (Suarez, 2020). As a result, most institutions have relaxed the assessment criteria, so that the academic performance is not affected (Suarez, 2020). Basically, universities and colleges have to ask their teaching staff members to be more flexible, encouraging them to take into account both the economic and social situation of the students (Suarez, 2020).

Still, the assessment of student learning is crucial for assuring quality in online education and other environments, and its results should be used to evaluate the relevance of the instructional design and delivery (Bao, 2020). Moreover, the stakeholders' needs that were identified during this thesis are even more relevant during the pandemic. Students need further assistance from faculty and teaching assistants, teaching staff need support to face unexpected incidents in online platforms, and managers need quality information to decide how to reinvent the curriculum and run their campus (Bao, 2020; IAU, 2020). To meet these needs, many universities are responding in diverse ways, not likely discussing and studying the changes implemented as a response to the rapid digitalization of the curriculum (Crawford et al., 2020). Therefore, it is crucial to engage all stakeholders with continuous curriculum improvement, aiming to ensure that student learning is assessed in a meaningful way during and after COVID-19.

In order to visualize medium- and long-term scenarios, it is important to capture what is happening and what will be the consequences for higher education stakeholders (IAU, 2020). In Latin America, higher education leaders have had to overcome persisting and emerging issues, and institutions have to reinvent themselves to avoid lagging behind (Suarez, 2020). In this context, future work should create significant opportunities to learn from the pedagogical elements of other universities and colleges, strengthening the collective response of the higher education sector to stakeholders' needs during and after COVID-19. In conclusion, it is clear that the future of higher education needs rethinking in many ways, so high quality education and research will be needed to rebuild our society (IAU, 2020).

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GLOSSARY

Concept	**Definition**	**Reference**
Higher Education Curriculum	Academic plan that influences what, why, and how students learn throughout eight elements: 1) purpose, 2) content, 3) sequence, 4) learners, 5) instructional processes, 6) instructional materials, 7) evaluation, and 8) adjustment.	Lattuca, L. R., & Stark, J. S. (2009). Shaping the College Curriculum: Academic Plans in Context (Second Edi). San Francisco: Jossey-Bass. Retrieved from
Student Outcomes	Knowledge and abilities that students are expected to attain at the time of graduation. These relate to the skills, knowledge, and behaviours that students acquire as they progress throughout an academic program.	ABET (2015). Institute for the Development of Excellence in Assessment Leadership (IDEAL). Retrieved from IDEAL materials.
Continuous Curriculum Improvement	Systematic assessment of student outcomes in specific courses of an academic program, in order to evaluate the effectiveness of curriculum and teaching practices in terms of learning results.	Proposed by this thesis based on Harper, B. J., & Lattuca, L. R. (2010). Tightening Curricular Connections: CQI and Effective Curriculum Planning. Research in Higher Education, 51, 505–527.
Learning Analytics	Measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which occurs.	Siemens, G., & Gasevic, D. (2012). Guest Editorial - Learning and Knowledge Analytics. Educational Technology & Society, 15 (3), 1–2.
Curriculum Analytics	Collection, analysis and visualization of program- and course-level data, such as program structure and course grading, to inform curriculum renewal strategies at an institutional level.	Proposed by this thesis based on Ochoa, X. (2016). Simple metrics for curricular analytics. In CEUR Workshop Proceedings (Vol. 1590, pp. 20–26).

Concept	Definition	Reference
Quality Culture	An organisational culture that intends to enhance quality permanently and is characterised by two distinct elements: on the one hand, a cultural/psychological element of shared values, beliefs, expectations and commitment towards quality and on the other hand, a structural/managerial element with defined processes that enhance quality and aim at coordinating individual efforts of students, teaching staff, and managers.	European University Association. (2006). Quality Culture in European Universities: A bottom-up approach. Report on the three rounds of the quality culture project 2002–2006. Brussels: EUA.
Higher Education Stakeholders	External and internal influences that affect curriculum decision-making. Internal influences allude to governance at an institutional level, besides managers, teaching staff and students. External influences allude to disciplinary associations, accrediting agencies, market forces, and governmental demands; among others.	Lattuca, L. R., & Stark, J. S. (2009). Shaping the College Curriculum: Academic Plans in Context (Second Edi). San Francisco: Jossey-Bass. Retrieved from
Mixed Methods	Procedure of collecting, analysing, and integrating both quantitative and qualitative research methods in a single study or a series of studies to understand a research problem.	Creswell, J. W. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research. Educational Research (4th Edition). Boston, Massachussetts: Pearson Education, Inc.

APPENDICES

APPENDIX A: PROTOCOL FOR COLLECTING QUALITATIVE DATA TO ASSESS STAKEHOLDERS' NEEDS FOR LEARNING ANALYTICS

- This protocol is based on materials generated by the SHEILA project (https://sheilaproject.eu/sheila-framework/) and adapted and used for the LALA project (https://www.lalaproject.org/).
- It is suggested to consider two people to lead each interview: a moderator (who asks the questions) and an observer (who takes notes).
- The moderator should be familiar with qualitative methodologies.
- The time for the activity should be about an hour.
- The idea is to start by *framing* and ask for informed consent in writing.

Managers	**Teaching staff**	**Students**
Methodology: Snowball until obtaining redundant information (start with key actors and suggest that they refer someone else to talk to). Number of participants: At least one (unless the authority decides to add more). Examples of key players: • Vice Chancellor • Deans/Teaching Directors • Deans of faculties • Career Coordinators • Student welfare • Director of Information Technology	Methodology: Sampling by convenience in different Faculties relevant for the institution (ideally at least one per faculty) Number of participants: At least three (it is suggested citing six to eight people).	Methodology: Sampling by convenience in different Faculties relevant for the institution (ideally at least one per faculty) Number of participants: At least three (it is suggested citing six to eight people).

Framing

The learning analytics involves the collection and analysis of educational data, such as grades and class attendance, with the objective of obtaining information on how students approach their studies and implementing services to improve their learning processes. For example, alert systems can be developed to offer support to students who are at risk of failing a course or abandoning their studies. Systems that analyse the hours invested by a student in an online or face-to-face learning environment can also be developed, to determine the time spent on a course or module. In this way, the use of educational data in services based on learning analytics provides information to identify any type of problem that may affect the learning process of a student.

Considering that [your management/your teaching/your learning] can benefit from the use of educational data, it is very important to consider your opinions and expectations during the design and implementation of the different services. For this purpose, you have been invited to participate in this interview that will last approximately one hour. Its objective is to get to know your opinion about the use of your educational data by the university, and your expectations about the services that could be developed from this data.

The information collected in this interview will be used to inform about the development of policies associated with the use of educational data in different Latin American universities through a collaborative project funded by the European Commission. This interview will be recorded but this recording may be interrupted at any time a participant request it.

[Authorizing signature]

1.- Warming-up

Managers	**Teaching staff**	**Students**
1. Mention the position you currently hold and years of experience.	1. Mention the position you hold, the faculty/ school you belong to and years of experience.	1. Mention the career you are pursuing and in what semester/year you are currently.

Managers	**Teaching staff**		**Students**
2. What data is relevant to understand how students and professors are performing?	2a. What data is relevant to understand how *your students* are performing in their studies?	2b. What data is relevant to understand how you are doing *as a professor*?	2. What data is relevant for you to know how you are doing in your studies?
3. What data is provided to students and professors to give feedback on their performance? How effective is it?	3a. What data do you provide to students to give feedback on their academic performance? How effective is it?	3b. What data does the institution provide to give feedback on your teaching performance? How effective is it?	3. What data do the professors and the institution provide to give you feedback on your academic performance? How effective is it?

2- Exploring discussion points

Topic: Ethical considerations for the use of data

Managers	**Teaching staff**		**Students**
4. What types of data does the university collect about students and teaching staff?	4a. What types of data do you think the university has been collecting about you?	4b. What types of data do you think the university has been collecting about students?	4. What types of data do you think the university has been collecting about you?
5. Do teaching staff and students sign any consent forms where they are told that their data will be used? When?	5a. Have you signed any consent form where you were told that your data will be used? When??	5b. Do you know if the students have signed a consent form where they are told their data will be used? When?	5. Have you signed any consent form where you are told that your data will be used? When?

Managers	**Teaching staff**		**Students**
6. Are there policies available on how the university collects and analyses the data of teaching staff and students??	6a. Are there policies available about how the university collects and analyses your data and that of your students??	6b. Do you know if students are informed about the way the university collects and analyses their data?	6. Is there clear information available about how the university collects and analyses your data?
7. Is there a policy to determine who has access to the data that the university collects about students and teaching staff? Who has access to the data?	7a. Do you know who has access to your data? Who should be granted the right to access your data? Should you be informed about who can access your data?	7b. Do you know who has access to students' data? Who should be granted the right to access their data? Should you be informed about who can access their data?	7. Do you know who has access to your data? Who should be granted the right to access your data? Should you be informed about who can access your data?
8. Is there some type of data for which the university should explicitly ask for teaching staff' and students' consent (for example, data about their religious beliefs)?	8a. Is there some type of data for which the university should explicitly ask for your consent (for example, data about your religious beliefs)?	8b. Is there some type of data for which the university should explicitly ask for the students' consent (for example, data about their religious beliefs)?	8. Is there some type of data for which the university should explicitly ask for your consent (for example, data about your religious beliefs)?
Topic: Academic Use of Data			
Managers	**Teaching Staff**		**Students**
9. What use does the institution give to the data collected from students and teaching staff to improve their academic and	9. These are some examples of the use of data to help students in their learning. Which of these examples would you prefer to implement? Organize them in order of importance.		9. These are some examples of the use of your data to help you learn. Which of these examples would you prefer to implement? Organize in order of

Managers	**Teaching staff**	**Students**
teaching performance? Provide some examples.	a. Improving the advice, they receive from the teaching staff or with the academic tutors. b. Improving their learning experience as a whole, and their well-being. c. Detecting weak points in their learning and suggesting ways to improve it. d. Alerting the teaching staff as soon as possible, if they are at risk of failing a module, course), or if they could improve their learning. e. Identifying, based on their curriculum, the optimal path for their studies (for example, suggesting optional subjects). f. Offering them their complete learning profile in each module.	importance. a. Improving the advice, you receive from the teaching staff or with the academic tutors. b. Improving your learning experience as a whole, and your well-being. c. Detecting weak points in your learning and suggesting ways to improve it. d. Alerting the teaching staff as soon as possible, if you are at risk of failing a module, course, or if you could improve your learning. e. Identifying, based on your curriculum, the optimal path for your studies (for example, suggesting optional subjects). f. Offering you your complete learning profile in each module.
10/11 How else could student and professor data be used to improve understanding of their academic and teaching performance at the university?	10. How else could student data be used to improve understanding of their academic performance at the university?	10. How else could your data be used to improve understanding of your academic performance at the university?

Managers	**Teaching staff**	**Students**
	11. How could the data you get from students be used to improve understanding of your teaching practice at the university?	11. How could the data you get from the professors be used to improve the understanding of your performance at the university?
Topic: Data-based Feedback		
Managers	**Teaching staff**	**Students**
12. What would be the best way to show the results of the educational data analysis?	12. What would be the best way to show the results of the educational data analysis? (teaching staff and students)	12. How would you like to receive the results of the analysis of your educational data? [In person (for example, from your academic tutor) As a text (for example, by email), through visualizations (for example, through a graphic interface in a software tool).]
13. How often should the results be sent? For example, every day, once a week, etc.	13. How often would you like to receive the results? For example, every day, once a week, etc. (teaching staff and students)	13. How often would you like to receive the results? For example, every day, once a week, etc.
14. Should the results include a comparison of the professor's/student's progress with respect to the progress of the rest of their colleagues?	14. Should the results include a comparison of your progress with respect to the progress of the rest of your colleagues?	14. Should the results include a comparison of your progress with respect to the progress of the rest of your classmates?
Topic: Data-related actions		
Managers	**Teaching Staff**	**Students**

Managers	**Teaching staff**		**Students**
15. How are the results of teaching staff' and students' data approached? What actions are taken? What actions should be taken?	15. How are the results of your data approached? What actions are taken? What actions should be taken?	15. How are the results of students' data approached? What actions are taken? What actions should be taken?	15. How do they approach the results of your data? What actions are taken? What actions should be taken? How should the institution approach the analysis of your data?

3.- Closing activities

Managers	**Teaching staff**	**Students**
16. Is there any additional information that would be important to obtain from students and teaching staff? Why?	16. Is there any additional information that would be important to obtain from students and you? Why?	16. Is there any additional information that would be important to obtain teaching staff and you? Why?
17. Would you like to add anything else?		

APPENDIX B: PROTOCOL FOR COLLECTING QUANTITATIVE DATA ABOUT EXPECTATIONS FOR LEARNING ANALYTICS

Student's expectations about the use of educational data[2]

Different higher education institutions have implemented support services for the learning process of their students from the collection and analysis of different educational data, such as grades, class attendance, or access to electronic resources (i.e. an alert system for students who are at risk of failing a course).

In this context, the purpose of this survey is to get to know the students' opinion about the collection and analysis of educational data in their institution. Answering the survey takes approximately 5 minutes and your participation is voluntary.

The following statements describe situations **that could occur in the future** given the progress of research on the use of educational data in higher education institutions. For each of the statements, indicate the degree of agreement or disagreement by marking an option from 1 to 7 on each scale, where 1 indicates disagreement and 7 indicates agreement.

A set of questions represents whether **you would like** the events described in the statement to happen at your university. Note: If what is described in the statement is something that you consider highly desirable, select the maximum value on the scale (7).

Another set of questions represents your perception of **what could actually happen at your institution** (in relation to what is described in the statement). Note: If the description in the statement is something already implemented at your institution or you think it is highly likely to happen, select the maximum value on the scale (7).

The results of the survey will be used to develop policies associated with the collection and analysis of educational data at different Latin American universities through the project *Building Capacity to Use Learning Analytics to Improve Higher Education in Latin America* (LALA) (https://lalaproject.org/), which is financed by the European Commission and has Latin American and European universities participating. Your answers will be anonymous and will only be disclosed at the aggregate level.

Please, check the box to confirm that you have read the information above.

☐

[2] Based on the instruments for data collection created by the SHEILA project (https://sheilaproject.eu/sheila-framework/) and used in the LALA project (https://www.lalaproject.org/)

Characterization

Place of residence before starting your university studies:			
Gender	Male	Female	I prefer not to respond.
Age			
At what Faculty are you studying? (Check <u>one</u> option)	Agronomy and Forestry Engineering		
	Architecture, Design and Urban Studies		
	Arts		
	Biological Sciences		
	Economics and Administration		
	Social Sciences		
	Communications		
	Literary Arts		
	Law		
	Education		
	Philosophy		
	Physics		
	History, Geography and Political Science		
	Engineering		
	Mathematics		
	Medicine		
	Chemistry		
	Theology		
What degree are you studying for? (check <u>one</u> option)	Undergraduate		
	Master's Degree		
	Doctorate		
Chilean or international student? (check <u>one</u> option)	Chilean		
	International		

EXPECTATIONS ON THE USE OF EDUCATIONAL DATA AT MY UNIVERSITY

1. The university will request my consent before using any personal data (for example, ethnicity, age or gender).

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

2. The university will make sure to keep my educational data safe.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

3. The university will request my consent before sharing my educational data with other institutions or companies.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

4. The university will inform me regularly about the progress of my learning, based on the analysis of my educational data.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

5. The university will request my consent to collect, use and analyse any of my educational data (for example, grades, attendance data or access to e-learning environments).

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

6. The university will request a new consent if my educational data will be used for a purpose other than the original one.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

7. The services related to the use of educational data will be used to promote students' decision-making (for example, by encouraging the student to adjust their own learning objectives through the feedback information provided to them).

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

8. The services related to the use of educational data will compare my progress to my learning objectives or to the objectives of my courses.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

9. The services related to the use of educational data will show me a complete profile of my learning in the courses (for example, number of accesses to an electronic resource or attendance data).

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

10. The teaching staff will be able to provide me with information and support based on the results obtained through the analysis of my educational data.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

11. The teaching staff will have the obligation to support me if the results obtained from the analysis of my educational data show that my performance is below average, that I am at risk of suspension, or that I can improve my learning.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

12. The information obtained through the services related with the use of my educational data will be used to promote the development of academic and professional skills for my future employability (for example, effective communication).

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

Teaching staff's expectations about the use of educational data

Different higher education institutions have implemented support services for the learning process of their students from the collection and analysis of different educational data, such as grades, class attendance, or access to electronic resources (i.e. an alert system for students who are at risk of failing a subject).

In this context, the purpose of this survey is to get to know the opinion of a university's teaching staff about the collection and analysis of **educational data** in their institution. Answering the survey takes approximately 10 minutes and your participation is voluntary.

The following statements describe situations that could occur in the future given the progress of research on the use of educational data in higher education institutions. For each of the statements, indicate the degree of agreement or disagreement by marking an option from 1 to 7 on each scale, where 1 indicates disagreement and 7 indicates agreement.

A set of questions represents **whether you would like** what is described in the statement to happen at your university. Note: If what is described in the statement is something that you consider highly desirable, select the maximum value on the scale (7).

Another set of questions represents **your perception of what could actually happen** at your institution (in relation to what is described in the statement). Note: If the description in the statement is something already implemented at your institution or you think it is highly likely to happen, select the maximum value on the scale (7).

The results of the survey will be used to develop policies associated with the collection and analysis of educational data at different Latin American universities through the project *Building Capacity to Use Learning Analytics to Improve Higher Education in Latin America* (LALA) (https://lalaproject.org/), which is financed by the European Commission and has Latin American and European universities participating. Your answers will be anonymous and will only be disclosed at the aggregate level.

Please, check the box to confirm that you have read the information above.

☐

CHARACTERIZATION

Gender	Male	Female
Years of teaching experience		
Faculty (Check <u>one</u> option)	Agronomy and Forestry Engineering	
	Architecture, Design and Urban Studies	
	Arts	
	Biological Sciences	
	Economics and Administration	
	Social Sciences	
	Communications	
	Literary Arts	
	Law	
	Education	
	Philosophy	
	Physics	
	History, Geography and Political Science	
	Engineering	
	Mathematics	
	Medicine	
	Chemistry	
	Theology	
Academic category	Assistant Professor	
	Deputy Assistant Professor	
	Associate Professor	
	Adjunct Associate Professor	
	Tenured Professor	
	Attached Titular Professor	
Management position	Chair of Undergraduate Program	
	Chair of Postgraduate Program	
	Chair of Research Program	
	Dean	
	Director at the level of Vice-chancellor	
	Vice-Chancellor	
	Other	
	Not applicable	
Chilean or international professor? (check one option)	Chilean	
	International	

TEACHING STAFF'S EXPECTATIONS ABOUT THE USE OF EDUCATIONAL DATA

1. The university will provide me with a manual on how to access the analysis of my students' educational data.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

2. The university will provide the teaching staff with opportunities for professional development in the use of educational data for teaching.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

3. The university will facilitate open discussions in which the experiences related to the services associated with the use of educational data can be shared.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

4. I will be able to access the data related to my students' progress, in any of the courses in which I am teaching or providing tutoring services.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

5. I will be able to access the data of any student who is in a program.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

6. The services related to the use of educational data will allow students to make their own decisions based on the information provided.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

7. The university will provide support to the student as soon as possible (for example, advice from the tutor) if the analysis of the student's educational data suggests that he may be having some difficulty or problem (for example, if the student is found to have poor performance, or a high risk of dropping a course).

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

8. The university will regularly inform the students about their educational progress, based on the analysis of their educational data.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

9. The services related to the use of educational data will collect and show accurate data (error-free data, for example, data without erroneous evaluation results).

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

10. The services related to the use of educational data will show a comparison between the students' progress in their learning and the learning objectives of their courses.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

11. The information provided by the services related to the use of educational data will be displayed in an understandable and easy-to-read format.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

12. The services related to the use of educational data will show students a complete profile of their learning in each of their courses (for example, number of accesses to online materials, attendance data or results obtained).

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

13. The teaching staff will be able to incorporate the results obtained through the analysis of the educational data in the information and support that they provide to the students.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

14. The teaching staff will have the obligation to support the students if the analysis of the students' educational data shows that they have a low performance, that they are at risk of being suspended, or that they can improve their learning.

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

15. The information obtained through the services related to the use of educational data will be used to promote the development of students' academic and professional skills for future employability (for example, effective communication).

Ideally, I would like it to happen **I think it can actually happen**

I disagree I agree I disagree I agree

1	2	3	4	5	6	7

1	2	3	4	5	6	7

16. The analysis of educational data will allow me to better understand the learning process of my students and their academic results.

Ideally, I would like it to happen							**I think it can actually happen**						
I disagree						I agree	I disagree						I agree
1	2	3	4	5	6	7	1	2	3	4	5	6	7

APPENDIX C: PROTOCOL FOR DEVELOPING A INSTRUMENTAL CASE STUDY ABOUT THE USE OF A CURRICULUM ANALYTICS TOOL

Overview

- **Purpose:** To evaluate the use of a curriculum analytics tool to support continuous curriculum improvement in a higher education institution.
- **Case study question:** How does the use of curriculum analytics tool support continuous curriculum improvement in a higher education institution?
- **Theoretical framework:** Over the past decade, researchers have developed curriculum analytics tools to address multiple educational challenges from the perspective of different stakeholders. Table A-1 summarizes some of the tools that have been documented in recent conference proceedings and journal articles describing the institution in which they were developed, and their distinctive features for different users. Concerning students, tools 1 and 2 were developed with the objective of changing their approach to study, using visualizations of their performance to motivate them to adopt help-seeking behaviours. Regarding teaching staff and managers, tools 3-10 were developed with the objective of providing information to identify students who are facing difficulties in their studies, expecting staff to reach out to their students and provide guidance. Finally, tools 11-14 were developed for students or staff, aiming to help them to identify crucial courses in a curriculum, and anticipate the impact of course-level improvements in competency attainment at a program level.

  Most of the tools presented in Table 1 do not provide information about the methodology used to evaluate its impact on any existing institutional processes. By methodology, we mean experimental approaches to determine whether the tool is effectively fulfilling its objective (Zelkowitz, 2009). For instance, little is known about how students perceived the tools developed to promote help-seeking behaviours (such as tool 1) (Sclater et al., 2016). Regarding tools that aim to identify students at risk (such as tool 9), there is no clear relationship between the use of the tool and student outcomes yet (Sclater et al., 2016). And, concerning the tools for monitoring course-level improvement and competency attainment, researchers have just started to evaluate their adoption by collecting information about user perceptions (Chou et al., 2015), without necessarily reporting data about its actual use to drive improvements in program design or academic program delivery (Greer, Molinaro, et al., 2016).

Table A-1. Curriculum analytics tools documented in the recent literature

Tool name and user	Developer	Distinctive features (References)
1. Check My Activity (focused on students)	University of Maryland, Baltimore, USA	Student visualizations of LMS logs compared to their peers and their grades (Pistilli & Heileman, 2017; Sclater et al. 2016)
2. E^2 Coach (focused on students)	University of Michigan, USA	Student visualizations of feedback based on peer performance (Pistilli & Heileman, 2017)
3. Student Relationship Engagement System (focused on teaching staff)	University of Sydney, Australia (used in 58 courses)	Interface for customizable analysis of students' academic performance datasets and visualizations (Greer, Molinaro, et al., 2016)
4. Risk management model (focused on managers and teaching staff)	The University of Queensland, Australia (piloting phase)	A set of risk indicators at a program and course level (Greer, Molinaro, et al., 2016)
5. The Ribbon Tool (focused	UC Davis, USA (disseminated	Sankey diagram to understand

Tool name and user	Developer	Distinctive features (References)
on managers and teaching staff)	to be used by other higher education institutions)	students' academic trajectories (Greer, Molinaro, et al., 2016)
6. Know your students (focused on teaching staff)	UC Davis, USA	Dashboard interface with students' demographic data at a course level (Greer, Molinaro, et al., 2016)
7. Departmental Diagnostic Dashboard (focused on managers)	UC Davis, USA	Dashboard interface with students' demographic data at a course level (Greer, Molinaro, et al., 2016)
8. Learning dashboard for Insights and Support during Study Advice-LISSA (focused on student advisers)	KU Leuven, Belgium	Dashboard with information about student course enrolment, course credits earned, and grades of one or more students (Charleer, Moere, Klerkx, Verbert, & Laet, 2018)
9. Course Signals (focused on teaching staff)	Purdue University, USA (licensed to Ellucian)	A set of risk indicators to classify students in subgroups (Pistilli & Heileman, 2017; Sclater et al., 2016)
10. Student Flow Diagrams (focused on managers and teaching staff)	University of New Mexico, USA	Sankey diagram to understand students' academic trajectories (Pistilli & Heileman, 2017)
11. Curricular Analytics (focused on managers, teaching staff)	University of New Mexico, USA	Interactive graphical representation of the curriculum (Pistilli & Heileman, 2017)
12. Visualized Analytics of Core Competencies-VACCs (focused on students)	Yuan Ze University, Taiwan (currently used in Yuan Ze University)	Visualization of competency attainment in radar charts regarding grades, credit hours and peer performance (Chou et al., 2015)
13. Competency Analytics Tool-CAT (focused on managers and staff)	Singapore Management University, Singapore	Curriculum progression statistics based on competency map and course information (Gottipati & Shankararaman, 2017)
14. Course University Study Portal-CUSP (focused on managers and teaching staff)	University of Sydney, Australia	Web-based application to model competency development in 5 maturity levels (Gluga et al., 2010)

- **Role of the protocol:** To ensure the case study reliability by documenting how its design responds the research question stated.

Working definitions

Teaching staff: different roles who teach at the research site, including faculty members (program chairs, associate and assistant professors), adjunct professors o professors of practices, and part time instructors.

Outcome assessment tasks: to plan how to collect evidence of the student outcome assigned by using course assessment methods, and to report the assessment results at the end of the semester.

Curriculum discussions: to discuss them with the program chair and part of the teaching staff in an end-of-semester meeting.

Outcome assessment tasks: to plan how to collect evidence of the student outcome assigned by using course assessment methods, and to report the assessment results at the end of the semester.

Continuous curriculum improvement: Systematic assessment of student outcomes in specific courses of an academic program, in order to evaluate the effectiveness of curriculum and teaching practices in terms of learning results.

Data collection procedures

- **Application for ethical approval**
- **Contact persons for fieldwork:**

    - Faculty members who participated in outcome assessment tasks and curriculum discussions
    - Teaching assistants who supported outcome assessment tasks
- **Expected preparation prior to fieldwork:**
    - Literature review
    - Protocol discussion with other researchers
    - Presentations of case study design to key external informants
- **Data collection plan**
    - Documentary evidence
        - Documents:
            - Assessment plans
            - Sample of assessment methods
            - Student outcome attainment
            - Course syllabus
            - Course descriptions
            - Reports of outcome attainment
    - Questionnaire

Documentary analysis

Coding scheme to analyse the documentary evidence collected throughout a continuous improvement process

Categories	Category description
Reported assessment plans (0)	The teaching staff did not report an assessment plan informing how course assessment methods were used to measure competency attainment.
Reported assessment plans (1)	The teaching staff reported an assessment plan to inform how course assessment methods were used to measure competency attainment at a course section level.
Reported a sample of assessment methods (0)	The teaching staff did not report a sample of assessment methods to account for different levels of competency attainment among different students.
Reported a sample of assessment methods (1)	The teaching staff reported a sample of assessment methods to account for different levels of competency attainment, such as developing or satisfactory.
Reported competency attainment results (0)	The teaching staff did not report competency attainment results at a course section level.
Reported competency attainment results (1)	The course reported competency attainment results based on graded assessments at a course level.
Reported course syllabus (0)	The teaching staff did not report the course syllabus to complement the evidence items for the accreditation process.
Reported course syllabus (1)	The teaching staff reported the course syllabus as a complement to other evidence items reported for the accreditation process.
Included a course description (0)	The teaching staff did not include a course description among the evidence items uploaded in the CA tool.
Included a course description (1)	The teaching staff included a course description among the evidence items uploaded in the CA tool.

Categories	Category description
Reported percentages of competency attainment (0)	The teaching staff did not reported percentages of competency attainment.
Reported percentages of competency attainment (1)	The teaching staff reported percentages of competency attainment at a program level.

Data gathering techniques

Questionnaire

The following questionnaire has been designed by the Engineering Education unit to obtain your feedback on the use of the Curriculum Analytics (CA) tool for the continuous improvement process. Your answers will be confidential, and they will allow us to improve this tool in the future. The survey is voluntary and answering should not take more than 5 minutes.

Have you uploaded documentary evidence of a course in the CA tool to account for outcome evidence?

a. Yes
b. No
c. N/A

What use would you give to the CA tool after interacting with it?

What kind of information would you expect from this tool?

What do you think the CA tool lacks in terms of information and functionality?

Indicate your level of agreement with the following statements by marking with a cross one cell per row.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
a. The CA tool allows me to obtain more information about courses than other tools.					
b. The CA tool allows me to obtain information easily.					
c. The purpose of using CA tool is clear and understandable.					
d. It is easy to learn how to use the CA tool.					
e. In general, the CA tool seems useful for curriculum management.					

Gender

- Female
- Male

Age: _____

Nationality: _____

Extracurricular activities in which you participate actively:

Technological devices you use regularly:

Social networks you use regularly:

Case study analysis

- Coding of documentary evidence according to coding scheme, and cross-checking revisions in three rounds with three researchers
- Statistical analysis of the questionnaire responses, estimating the percentage of respondents who agreed with the items about usability and perceived usefulness of the curriculum analytics tool (counting the number of respondents whose scores were equal or higher than 4, and then dividing them by the number of total respondents)
- Data triangulation of two sources of evidence:

	Documentary Analysis	Questionnaire Responses
Findings regarding the usability and perceived usefulness of the curriculum analytics tool	Coding references	Percentage of respondents who agreed with items about usability and perceived usefulness

Case study report

- **Discussion on case study reporting with co-authors**
- **Case study audience:** Although CA has been proposed as a promising complement to LA (Greer, Molinaro, et al., 2016), curriculum analysis remains manual and course-specific (Gottipati & Shankararaman, 2017). Regardless of the potential of using analytical tools to gain better understanding of the effectiveness of curriculum strategies and program outcomes, its overall impact on program-level decision-making remains unknown (Sclater, 2018). On the one hand, stakeholders' perceptions and preferences are still the main sources of information to be used for the revision of the higher education curriculum (Ochoa, 2016). On the other hand, managers and teaching staff have not been exposed to the use of these tools, so they do not understand the capabilities and limitations of its use to drive improvement actions (Greer, Molinaro, et al., 2016). More research is needed to understand how CA tools could support continuous curriculum improvement in real-world university settings.
- **Revisit purpose to describe contributions:** One of the main contributions of this instrumental case study is to guide the evaluation of the use of a CA tool in an existing institutional process for an extended period of time, going beyond current evaluation strategies that mostly employ self-reported data without relying on a technology validation methodology. The documentary analysis should consider evidence items of an extended period in time in which a curriculum change or a continuous improvement process was implemented at a program level. This long-term period assured collecting enough

information to determine whether a curriculum analytics tool facilitated teaching staff efforts to continuously improve the curriculum.

- **Exhibits to be developed:**
  - Database resulting from applying questionnaires
  - Database resulting from analysing documentary evidence
  - Consent forms

References

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APPENDIX D: PROTOCOL FOR DEVELOPING A FIELD STUDY ABOUT THE IMPACT OF A CURRICULUM ANALYTICS TOOL

Overview

- **Purpose:** To evaluate the impact of a curriculum analytics tool to support continuous curriculum improvement in a higher education institution.
- **Field study question:** How can a curriculum analytics tool support continuous curriculum improvement in higher education settings?
- **Theoretical framework:** To reach a higher level of achievement of graduation competencies, universities must constantly evaluate the effectiveness of their curricula (Bouwma-Gearhart & Hora, 2016; Schoepp & Tezcan-unal, 2017). According to Lattuca and Stark (2009), this evaluation not only involves evaluating the relevance of the competencies of a study plan, but also the sequence of the courses, their contents, the teaching-learning activities, the evaluation, and the pedagogical resources used. To make the necessary adjustments to improve learning outcomes, managers and teachers in higher education institutions should systematically review the alignment between these elements and the competencies required by modern society (Gottipati & Shankararaman, 2017), such as critical thinking, problem solving, communication and teamwork.

  However, curricular management is generally done retroactively, with no access to the achievements of the competencies in real time (Bouwma-Gearhart & Hora, 2016). To support this process, various analytical tools have been proposed to facilitate access to data from courses and study plans (Gottipati & Shankararaman, 2017). However, managers and teachers still perceive that they lack systematic information to improve the courses, such as the students' learning outcomes regarding the courses taken (Chou et al 2015). Furthermore, most of the tools developed were not designed to be used in an institutional process, and their visualizations do not provide actionable information for managers or teachers in an existing higher education institution.

  Research on the design and implementation of analytical tools for curriculum management is still at an early stage. To expand knowledge in this field and understand how the adoption of analytical tools could systematically support the continuous improvement of higher education curricula, we present design-based research approach to evaluate the use and perceived usefulness of a curriculum analytics tool to support continuous curriculum improvement.
- **Role of the protocol:** To ensure the reliability of the field study by documenting how its design responds the research question stated.

Working definitions

Teaching staff: different roles who teach at the research site, including faculty members (program chairs, associate and assistant professors), adjunct professors o professors of practices, and part time instructors.

Outcome assessment tasks: to plan how to collect evidence of the student outcome assigned by using course assessment methods, and to report the assessment results at the end of the semester.

Curriculum discussions: to discuss them with the program chair and part of the teaching staff in an end-of-semester meeting.

Outcome assessment tasks: to plan how to collect evidence of the student outcome assigned by using course assessment methods, and to report the assessment results at the end of the semester.

Continuous curriculum improvement: Systematic assessment of student outcomes in specific courses of an academic program, in order to evaluate the effectiveness of curriculum and teaching practices in terms of learning results.

Curriculum analytics: Collection, analysis, and visualization of program- and course-level data, such as program structure and course grading, to inform curriculum renewal strategies at an institutional level.

Protocol for conducting workshops with managers and teaching staff affiliated with different universities

The workshops will have a maximum duration of two hours, under the following structure:

Time	Activity
15”	Initial coffee break: Registration of participants Handing out general study information and signing the consent form to participate in the experiment Handing out folders with material (*)
15”	Presentation about the workshop: Description of the workshop’s objective Description of the work context and instructions
30”	Work on tasks for evaluation of functionalities
15”	Questionnaire application
30”	Final discussion

(*) The following material will be provided to every participant:

- Research project description sheet
- Informed consent form
- Glossary of curricular terms
- Brochures about the curriculum analytics tool, notebooks, pencils
- Sheet with description of the work context and instructions
- Sheet with list of tasks to be performed to evaluate the functionalities of the tool
- A stack of post-its
- Blank letter-size sheets

Data collection procedures

- **Application for ethical approval**
- **Contact persons for fieldwork:**
  - Managers from higher education institutions that use a curriculum analytics tool
  - Teaching staff affiliated with those higher education institutions
- **Expected preparation prior to fieldwork:**
  - Literature review
  - Protocol discussion with other researchers
  - Presentations of field study design to key external informants
- **Data collection plan**
  - Interaction with curriculum analytics tool
  - Questionnaire
  - Discussion

Interaction with curriculum analytics tool

Teaching staffs' framing

You are affiliated with a higher education institution and teach a minimum course in the X curriculum called Y. This course is based on project learning and develops several transversal competencies. For this reason, the director of the X curriculum has asked you to collect evidence to account for the achievement of some of these competencies in the context of your course. To fulfil this task, you will access a curriculum analytics tool to review which competencies were assigned to your course and update the syllabus for the next period.

Tasks to be performed by teaching staff members in the curriculum analytics tool

Task	Module	Related material
1. Search for the syllabus of the course named 'Entrepreneurship and Innovation'	Syllabus	
2. Review competencies assigned to the course according to study plan	Syllabus	
3. Relate learning outcomes to competencies.	Syllabus	Word File "Syllabus"
4. Plan a couple of classes in the course	Syllabus	Word File "Syllabus"
5. Establish which assessments are linked to the learning results of the course	Syllabus	Word File "Syllabus"
6. Download the syllabus for students using the download report function	Syllabus	
7. Upload evidence used to measure competencies in Attachments tab	Syllabus	PDF files "TC rubrics (…)"
8. Review Competencies Outcomes report	Reports	

Managers' framing

You are the director of the X curriculum at a higher education institution. At the request of the Teaching Directorate of the Academic Vice-Rectory, the curricular committee of the X study plan has created a matrix of transversal competencies, and it is your responsibility to ensure that these competencies are developed in different courses of the study plan. Therefore, you have to access a curriculum analytics tool to create this competency matrix and assign these competencies to different courses in the study plan.

Tasks to be performed by managers in the curriculum analytics tool

Task	Module	Related material
1. Create a matrix of transversal competencies	Competencies	Word File "Competencies"
2. Link the competency matrix with study plan	Competencies	
3. Search "Engineering" study plan	Study plan	
4. Link transversal competencies with courses in the "Engineering" study plan	Study plan	Excel File "Mapping_CT"
5. Upload meeting minutes in the Attachments tab	Study plan	Word File "Meeting minutes"
6. Review Syllabus Tracking report	Report	
7. Review Competency attainment report	Syllabus	
8. Review other reports	Reports	

Questionnaire

Select the role you played during the workshop:

- Manager
- Teacher

In the case of a teacher:
Regarding your experience using the Curriculum analytics tool during the workshop, indicate your level of agreement with the following statements, where 1 means: I totally disagree and 10: I totally agree.

For this curriculum analytics tool it is clear what data is being collected.

1 2 3 4 5 6 7 8 9 10
I totally I totally
disagree agree

For this curriculum analytics tool it is clear why the data is being collected.

1 2 3 4 5 6 7 8 9 10
I totally I totally
disagree agree

This curriculum analytics tool makes me aware of the current learning situation of my students (the learning situation is the set of articulated activities that students will perform to acquire knowledge and develop skills in the context of a course or subject).

1 2 3 4 5 6 7 8 9 10
I totally I totally
disagree agree

This curriculum analytics tool allows me to anticipate my students' possible future learning situation given their (un)changed behaviour.

1 2 3 4 5 6 7 8 9 10
I totally I totally
disagree agree

This curriculum analytics tool stimulates me to reflect on my past teaching behaviour.

1 2 3 4 5 6 7 8 9 10
I totally I totally
disagree agree

This curriculum analytics tool stimulates me to adapt my teaching behaviour if necessary.

1 2 3 4 5 6 7 8 9 10
I totally I totally
disagree agree

This curriculum analytics tool stimulates to plan my courses more efficiently.

1 2 3 4 5 6 7 8 9 10

I totally disagree — I totally agree

This curriculum analytics tool stimulates me to plan my courses more effectively.

1 2 3 4 5 6 7 8 9 10

I totally disagree — I totally agree

In the case of managers:

Regarding your experience using the Curriculum analytics tool during the workshop, indicate your level of agreement with the following statements, where 1 means: I totally disagree and 10: I totally agree.

For this curriculum analytics tool it is clear what data is being collected.

1 2 3 4 5 6 7 8 9 10

I totally disagree — I totally agree

For this curriculum analytics tool it is clear what data is being collected.

1 2 3 4 5 6 7 8 9 10

I totally disagree — I totally agree

This curriculum analytics tool makes me aware of the current learning situation of my students (the learning situation is the set of articulated activities that students will perform to acquire knowledge and develop skills in the context of a course or subject).

1 2 3 4 5 6 7 8 9 10

I totally disagree — I totally agree

This curriculum analytics tool makes me forecast my students' possible future learning situation given their un(changed) behaviour.

1 2 3 4 5 6 7 8 9 10

I totally disagree — I totally agree

Curriculum analytics tool motivates me to reflect on my work as a manager.

1 2 3 4 5 6 7 8 9 10

I totally disagree — I totally agree

This curriculum analytics tool allows me to formulate curriculum improvement actions if necessary.

	1	2	3	4	5	6	7	8	9	10	
I totally disagree											I totally agree

This curriculum analytics tool allows me to monitor the quality of study plans more efficiently.

	1	2	3	4	5	6	7	8	9	10	
I totally disagree											I totally agree

This curriculum analytics tool allows me to monitor the quality of study plans more effectively.

	1	2	3	4	5	6	7	8	9	10	
I totally disagree											I totally agree

Regarding the personalization of the Curriculum analytics tool according to the curricular elements and concepts used in your university, how beneficial is having this personalization for the curricular management and the teaching and learning processes? Indicate the level of perceived benefit from 1 to 5, where 1 means: not at all beneficial, and 5: absolutely beneficial.

	1	2	3	4	5	
Not at all beneficial						Absolutely beneficial

How familiar are you with the Curriculum analytics tool that has been implemented at your university? Select the option below that best represents you.

- o I had not heard about the Curriculum analytics tool, nor did I know anything about it.
- o I had heard of the Curriculum analytics tool, but I did not know anything about it.
- o I knew about Curriculum analytics tool, but I had not interacted with it.
- o I knew about Curriculum analytics tool and had interacted with

Discussion

- From your perspective, what is the curriculum analytics tool for and who are its main users?
- In the case of adopting this tool to support continuous curriculum improvement processes, what improvement actions could be implemented based on the information provided by the tool?
- Considering the information that the tool currently provides, what additional information would be required to formulate actions to improve curricula and teachers?
- If you could redesign the current version of the tool, what other functionalities could be incorporated in a future version?
- Any other aspect that could be relevant for evaluation of the usefulness of this tool which have not been asked previously?
- Do you have any additional comments or suggestions regarding the tool or the workshop?

Field study analysis

- Statistical analysis of the questionnaire responses, following the steps suggested by (LACE, n.d.)[3] These steps imply (teaching staff separately from managers):
    - Calculating the average value for each item based on the answers given for every 10-point item in the questionnaire).
    - Calculating the average for each dimension based on the average of its items (item 1 and 2 correspond to the 'data' dimension, items 3-6 to the 'awareness and reflection' dimension, and items 9 and 10 to the 'impact' dimension)
    - Calculating the dimensional scores by rounding the result of ((x-1)/9)*100 where x is the average value of a dimension (in order to get a number between 0 and 100), and
    - Calculating the overall EFLA score by calculating the average of three-dimensional scores (EFLA: Evaluation Framework for Learning Analytics developed by Scheffel (2017)).
- Coding of workshop discussions, identifying participants' perspectives of the perceive usefulness of the curriculum analytics tool.
- Complementing information from these two sources of evidence:

	Questionnaire	Coding of workshop discussions
Impact of the use of the CA tool	Results of the questionnaire scales based on EFLA	-
Perceived usefulness of the CA tool	-	Frequency of coding references from different uses mentioned by workshop participants

Field study report

- **Discussion on case study reporting with co-authors**
- **Case study audience:** Although curriculum analytics has been proposed as a promising complement to LA (Greer, Molinaro, et al., 2016), curriculum analysis remains manual and course-specific (Gottipati & Shankararaman, 2017). Regardless of the potential of using analytical tools to gain better understanding of the effectiveness of curriculum strategies and program outcomes, its overall impact on program-level decision-making remains unknown (Sclater, 2018). On the one hand, stakeholders' perceptions and preferences are still the main sources of information to be used for the revision of the higher education curriculum (Ochoa, 2016). On the other hand, managers and teaching staff have not been exposed to the use of these tools, so they do not understand the capabilities and limitations of its use to drive improvement actions (Greer, Molinaro, et al., 2016). More research is needed to understand how CA tools could support continuous curriculum improvement in real-world university settings.

[3] http://www.laceproject.eu/evaluation-framework-for-la/

- **Revisit purpose to describe contributions:** This tool was developed by the U-Planner company and implemented in different Latin American universities. Information on the perceptions of teachers and managers on the usefulness of the tool was collected from two iterations, in addition to collecting information on aspects to consider for its redesign. In this regard, this work contributes with:
    - Lessons learned to guide the design, implementation, and adoption of analytical tools for continuous curriculum improvement in Latin American universities.
    - Considerations to guide the development and evaluation of new functionalities of the existing analytical tools to support curriculum management.
- **Exhibits to be developed:**
    - Field notes taken during workshops
    - Database resulting from applying questionnaires
    - Database resulting from analysing discussions at the end of workshops
    - Consent forms

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APPENDIX E: PROTOCOL FOR DEVELOPING A CASE STUDY ABOUT ENGAGEMENT WITH CONTINUOUS CURRICULUM IMPROVEMENT

Overview

- **Purpose:** To illustrate mechanisms to engage and disengage teaching staff in continuous curriculum improvement in a higher education institution.
- **Case study question:** How does the teaching staff of a higher education institution engage and disengage with continuous curriculum improvement?
- **Theoretical framework:** In higher education, continuous curriculum improvement has been subject to both internal and external influences. By continuous curriculum improvement, we refer to the iterative process of improving the academic plan, as it was defined by Lattuca and Stark (2009). And by internal influences and external influences, we refer to internal and external curriculum stakeholders, such as teaching staff and accrediting agencies respectively. However, over the past two decades, new external influences have started to rise, such as internationalization, volatile financial environments, technological changes, and changing student demographics (Kezar and Holcombe 2017; Shay 2016). As a consequence of increased external influences, higher education institutions have adopted centralized assessment frameworks to respond to external accountability demands, such as national and international accreditations. collected fulfils accountability criteria. However, there is no evidence centralizing assessment has improved teaching and learning as teachers and students are often underrepresented. Although it is understandable that a top-down approach is often desired to comply with multiple demands for accountability, this type of approach diminishes teaching staff agency in continuous curriculum improvement (Swarat et al. 2017), without necessarily improving the quality of teaching and learning (Brady and Bates 2016; Bendermacher et al. 2017). In this context, the European Association for Quality Assurance in Higher Education (ENQA) has introduced the term ‘quality culture’ to enhance the idea of continuous improvement ‘embraced by all’: students, teachers and institutional management (ENQA 2015, 5). Then, more empirical studies are needed about continuous improvement, particularly concerning the relationship established by an institution and its teaching staff and students (Busco, Dooner, and d’Alencon 2018).
- **Role of the protocol:** To ensure the case study reliability by documenting how its design responds the research question stated.

Working definitions

Teaching staff: different roles who teach at the research site, including faculty members (program chairs, associate and assistant professors), adjunct professors o professors of practices, and part time instructors.

Outcome assessment tasks: to plan how to collect evidence of the student outcome assigned by using course assessment methods, and to report the assessment results at the end of the semester.

Curriculum discussions: to discuss them with the program chair and part of the teaching staff in an end-of-semester meeting.

Data collection procedures

- **Application of ethical approval**
- **Contact persons for fieldwork:**

    - Program Chairs
    - Faculty members who participated in outcome assessment tasks and curriculum discussions
    - Teaching assistants who supported outcome assessment tasks
- **Expected preparation prior to fieldwork:**
    - Literature review
    - Protocol discussion with other researchers
    - Presentations of case study design to key external informants
- **Data collection plan**
    - Qualitative evidence
        - Documents:
            - Assessment plans
            - Meeting Minutes
        - Semi structured interviews with teaching staff
        - Semi structured interviews with teaching assistants

Documentary analysis

Coding scheme to analyse assessment plans

Categories	Category 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).

Coding scheme to analyse meeting minutes

Categories	Category description
Reflections on teaching	Teachers' comments on aspects of how they teach (e.g. comments on teaching methods they could integrate to their class).
Reflections on assessment	Teachers' comments on learning outcomes, assessment methods and/or the alignment (or misalignment) between them (e.g. comments on the relationship between assessment methods used and the indicators measured).
Reflections on the curriculum	Teachers' comment on aspects further than their course teaching and assessment methods by alluding to a 'big picture' of learning at a program level (e.g. comments on the curriculum map to show the contribution of different courses to student outcomes that are part of the graduate profile).

Data gathering techniques

Guide to interview program chairs and teaching staff at the research site.

Dimension	Guiding Question
Characterization of the teaching staff (Warm up)	1. Tell me briefly your experience in the School of Engineering, both as an academic and in management roles.
	2. What tasks did you have to perform in the Continuous Improvement System implemented between 2015 and 2017? What is the role professors take on in this system?
Teaching staff perspectives on the continuous improvement process	3. What impact does the continuous improvement system have on students? How does this continuous improvement system contribute to the improvement of the courses?
	4. What impact does the involvement of professors have on this system? How about the heads of programs? And, how about the assistants?
Engagement mechanisms	5. How important is to encourage the involvement of professors and students in this system? What could the school do to encourage the involvement of these actors?
Disengagement mechanisms	6. What elements of this system should be improved in your opinion?
Closing remarks	7. Would you like to add something that you have not been asked but that would be important to consider?

Guide to interview teaching assistants at the research site to complement teaching staff perspectives.

Dimension	Guiding Question
Characterization of teaching assistants (Warm up)	1. In order to get to know each other, I would be grateful if everyone would introduce themselves, briefly indicating their name, their study program and the course for which they were assistants during the continuous improvement system between 2015 and 2017.
	2. What tasks did you have to perform during your participation in the continuous improvement system? What is the role taken by the assistants in this system?
Teaching assistants' perspectives on the continuous improvement process	3. What impact does the continuous improvement system have on students? How does this continuous improvement system contribute to the improvement of the courses?
	4, What impact does the involvement of professors have on this system? And that of the assistants?
Engagement mechanisms	5. How important is to encourage the involvement of professors and students in this system? What could the school do to encourage the involvement of these actors?
Disengagement mechanisms	6. What elements of this system should be improved? How about the workshops? (if it has not been mentioned)
Closing remarks	7. Would you like to add something that you have not been asked but that would be important to consider?

Case study analysis

- Use of academic plan model of Lattuca and Stark (2009) as a logic model to understand top-down approaches for continuous curriculum improvement to comply with accreditation criteria (and explore implications or bottom-up approaches).
- Coding and cross-checking revisions in three rounds with three researchers
- Data triangulation of three sources of evidence:

	Semi-structured interviews	Assessment plans	Meeting memos
Engagement Mechanisms	Coding references	Category frequency distribution	Category frequency distribution
Disengagement Mechanisms	Coding references	Category frequency distribution	Category frequency distribution

Case study report

- **Discussion on case study reporting with co-authors**
- **Case study audience:** According to Steinhardt et al. (2017), the literature on quality assurance of teaching and learning is emerging from the field of higher education research. These authors reviewed systematically the literature related to this topic and there are different journals addressing issues in this matter, including: 1) Assessment and Evaluation in Higher Education, 2) Quality in Higher Education, 3) Higher Education, 4) Quality Assurance in Education, 5) Tertiary Education and Management, 6) Studies in Higher Education, 7) Higher Education Policy and 8) International Journal of Engineering Education. Results of this study show an abrupt increase in the number of related articles since 2005, demonstrating a linear growth of the publication rate. Although is too early to define this research theme as an specialty (Steinhard et al. 2017), there is a cohesive core of researchers working to build scientific knowledge about teaching and learning quality, improved course design (and didactics), improved student experience, system policy in higher education, institutional management for quality assurance, cultural elements and academic work. Along these lines, this paper intends to expand the growing research about quality. Still, it is not only targeted to scholars researching quality in higher education, but also senior and middle managers of higher education institutions addressing quality assurance processes.
- **Revisit purpose to describe contributions:** According to Busco, Dooner, and d'Alencon (2018), future research about quality assurance and improvement should address university management issues, such as the relationship established by the university and its stakeholders. In this context, the main research objective of this case study is to illustrate mechanisms used to engage and disengage teaching staff of an engineering school during a continuous improvement process, contributing to the existing body of knowledge with empirical findings about teaching staff perspectives.
- **Exhibits to be developed:**
    - Database resulting from coding assessment plans, meeting memos and semi-structured interviews to ensure reliability.
    - Consent forms
    - Analytic memos during coding
    - Reports from key internal reviewers' feedback

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