

Assessing 21st Century Competencies: A Two-Case Study on Curriculum Analytics to Inform Continuous Improvement in Higher Education

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Abstract

The growing emphasis on competency-based education (CBE) has heightened the need for clearly defined metrics and robust assessment frameworks to evaluate 21st-century competencies. Curriculum analytics (CA) provides a promising avenue for assessing learning outcomes (LOs) and informing continuous improvement in higher education. However, challenges persist in differentiating academic performance from actual LO development and in translating assessment data into meaningful program-level actions. This study examines how CA tools support the direct assessment of LOs and contribute to continuous improvement processes in higher education. Using a two-case study design, we analyzed CA implementation in two universities through interviews, cognitive walkthroughs, and institutional document analysis. Data triangulation identified 18 themes, nine of which reached full consensus among the three researchers. Findings indicate that CA tools effectively support the assessment of LOs aligned with 21st-century competencies by generating actionable insights that guide faculty toward more authentic and reflective teaching practices. The study contributes to the LA field by providing empirical evidence of how CA tools can bridge assessment and pedagogical improvement, offering both theoretical and practical implications for researchers and practitioners.

Notes for Practice

- Competency-based education has become increasingly important, particularly for developing 21st-century competencies such as communication and critical thinking.
- Curriculum analytics plays a critical role by enabling the assessment of learning outcomes associated with 21st-century competencies.
- This study addresses a key gap in the literature by showing how curriculum analytics supports the assessment of specific learning outcomes and strengthens continuous improvement processes.

Keywords: 21st century competencies, curriculum analytics, learning outcomes assessment, actionable insights, higher education

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1. Introduction

Competency-based education (CBE) has emerged as a major focus in educational research and pedagogical innovation, emphasizing the development and assessment of practical skills, cognitive abilities, and applied knowledge essential for success in today's complex and dynamic world (Johnstone & Soares, 2014; Li, 2022; Radu et al., 2024). Unlike traditional input-focused models, CBE and related outcome-based education approaches prioritize demonstrable improvements in learners' ability to solve problems, think critically, and apply knowledge effectively across diverse professional settings (Shanto et al., 2025; Yip & Smales, 2000). This shift aligns closely with the growing emphasis on 21st-century competencies, such as communication, creativity, collaboration, and lifelong learning, which are increasingly recognized as essential for professional and personal success (Buckingham Shum & Deakin Crick, 2016). As such, CBE not only supports the holistic

development of students but also calls for hands-on learning experiences that build these transversal competences (Pacher et al., 2024). By integrating clear metrics and learning taxonomies, CBE could enable institutions to align teaching strategies with the sequential development of competencies and continuous improvement (Asbari & Nurhayati, 2024; Shanto et al., 2025).

In a world where individuals are expected to navigate frequent career transitions and make informed educational and occupational decisions, 21st-century competencies, such as critical thinking, communication, and lifelong learning, are becoming increasingly essential (Gedrimiene et al., 2024). This technological shift not only heightens the urgency of cultivating these competencies among higher education students but also underscores the importance of clearly defined, relevant LOs. In our study context, LOs are linked to specific competences defined by the institution's curriculum framework (Agbo et al., 2024). This evolving landscape calls for a comprehensive educational approach that equips CBE frameworks with clear metrics to continuously assess and improve the attainment of future-ready competencies and the associated LOs (Buckingham & Deakin, 2016).

In this context, the growing use of data in education deepens the need for curriculum approaches that are both evidence-informed and adaptive, ensuring that learning pathways remain aligned with intended outcomes, so institutions can meaningfully track and enhance the development of critical 21st-century competencies (Agbo et al., 2024; Radu et al., 2024). Curriculum analytics (CA), a subfield of learning analytics (LA), offers timely and strategic opportunities to support the development and assessment of these competencies. According to Hilliger et al. (2020), CA involves systematically collecting, analyzing, and visualizing curricular data to inform program-level decision-making and continuous improvement. Recent studies indicate that these tools could offer scalable methods for tracking and visualizing competency development across programs (Barthakur et al., 2024; Divjak et al., 2025), thereby reducing the workload associated with manual assessment and enabling more targeted interventions (Barthakur et al., 2024; Hilliger et al., 2020). In this context, it may also support the use of performance tasks and other authentic assessments that capture actual student behaviour and the application of skills, essential for evaluating competencies such as critical thinking, collaboration, and decision-making (Porter et al., 2020). Moreover, CA frameworks can help teaching staff clarify expectations for students, thereby enhancing students' confidence and engagement in the learning process (Naujokaitiene et al., 2020). As lifelong learning and career adaptability become increasingly vital (Gedrimiene et al., 2024), CA could provide a foundation for aligning curriculum design with labour market demands and for continuously refining educational practices.

Despite its potential, the effective use of CA tools still faces persistent challenges, including the need to distinguish between academic performance and actual LO attainment (Hernández-Campos, Prado-Calderón, et al., 2025). To explore how CA can support the direct assessment of LO attainment to drive continuous improvement, this paper presents a multiple-case study conducted across two contrasting higher education institutions. Both institutions use CA tools integrated into their learning management systems (LMSs) to assess and visualize the attainment of LOs related to 21st-century competencies. Our study contributes to the broader discourse on 21st-century education by illustrating how CA can support the assessment and ongoing enhancement of LOs aligned with key professional competencies, thereby supporting continuous improvement. These include communication, collaboration, ethics, and the ability to apply knowledge in real-world contexts, competencies that are increasingly vital in today's rapidly evolving labour market. To support this objective, the following sections outline the background of CA's emergence as a research field, the methodological approach, and the findings from the cross-case analysis.

2. Background

2.1. Toward a Clearer Understanding of Learning Outcomes in LA

In the field of LA, assessing the attainment of LOs presents several challenges. One key issue is the lack of a clear, consistent definition, as many studies use the term without a solid theoretical grounding (Blumenstein, 2020; Namoun & Alshanjiti, 2021). In this study, we adopt a broad conceptualization of LOs that encompasses the knowledge, skills, and attitudes students develop during their academic journey, often extending beyond disciplinary boundaries (Brown & Grays, 2020; Caspersen & Smeby, 2018).

Another challenge lies in the diversity of assessment approaches, which complicates comparisons across programs and institutions. Common methods include course grades, indirect self-reports, and direct assessments of student performance (Leandro-Cruz et al., 2020). Each approach has its strengths and limitations: grades are readily available but primarily reflect content mastery (Caspersen & Smeby, 2018; Yorke, 2007); self-reports are cost-effective but susceptible to bias (Elbeck & Bacon, 2015; Weldy & Turnipseed, 2010); and direct assessments offer more objective and comparable evidence of skill development (Leandro-Cruz et al., 2020; Luce & Kirnan, 2016).

Importantly, direct assessment also encourages instructors to reflect on their teaching and evaluation practices, generating actionable insights that support course-level improvement (Bouwma-Gearhart & Hora, 2016; Hora, 2016; Jørnø & Gynther, 2018; Wise, 2018). This approach aligns closely with the concept of constructive alignment (Biggs, 1996), which emphasizes the systematic integration of intended LOs, teaching and learning activities, and assessment tasks. Constructive alignment

provides a theoretical foundation for understanding why consistent definitions and appropriate assessment strategies are essential: they ensure that what is taught, how it is taught, and how it is assessed are mutually reinforcing.

A robust conceptualization of LOs, coupled with aligned assessment strategies, is therefore critical for linking analytics to continuous improvement processes (De Silva et al., 2024; Dennehy et al., 2023; Guzmán-Valenzuela et al., 2021; Hernández-Campos, Hilliger, & García-Peñalvo, 2025; Kleimola & Leppisaari, 2022). Establishing greater consistency in definitions and assessment tools would enhance validity and comparability across educational contexts (Gray & Berner, 2022; Lagus et al., 2018; Leitner et al., 2019), ultimately strengthening the evidence base for CA and its role in supporting student learning and program quality.

2.2. Translating Learning Outcome Data Into Actionable Insights With CA

Given the practical value of integrating analytics with learning design to achieve targeted LOs (Albuquerque et al., 2025; Blumenstein, 2020; Divjak et al., 2025), CA offers a structured approach for generating actionable insights that inform curriculum improvement. Unlike traditional LA implementations, which often focus on student performance metrics without sufficient contextualization, CA leverages curriculum-level data—such as program structure, instructional methods, and assessment strategies—to evaluate how LOs are developed and achieved across courses (Barthakur et al., 2024; Gottipati & Shankaraman, 2018; Ochoa, 2016). This enables institutions to identify misalignments, monitor progress, and implement targeted interventions that enhance student learning and program quality.

A key strength of CA lies in its ability to translate LO attainment data into meaningful, context-sensitive improvement strategies. When embedded within institutional systems, CA tools can support transparent, systematic curriculum evaluation processes, providing educators with clear evidence to guide instructional design and program-level decisions (Hilliger et al., 2024). For example, recent work (Hernández-Campos, Hilliger, et al., 2025) demonstrates how CA tools can reveal gaps between intended competencies and actual learning experiences, providing actionable insights that inform curriculum redesign. Additionally, CA tools can help align academic programs with evolving societal and professional demands by mapping curriculum documentation to widely recognized educational constructs, such as Bloom's taxonomy (Kitto et al., 2020).

To ensure the effectiveness of these insights, CA must be grounded in a clear and shared understanding of what constitutes an LO, supported by reliable measurement methods and rigorous empirical designs (Kaliisa et al., 2023; Zilinskiene, 2022). A robust conceptual foundation not only enhances the interpretability of analytics outputs but also strengthens their relevance for decision-making. Standardized definitions and assessment tools improve the consistency and comparability of findings across diverse educational contexts, thereby reinforcing the evidence base for CA and its role in supporting continuous improvement (Gray & Berner, 2022; Hellas et al., 2018; Leitner et al., 2019).

Despite these advantages, the field of CA remains in its early stages. Few studies have explored how CA tools are adopted within ongoing institutional processes or how they influence decision-making over time (Hilliger et al., 2019). Moreover, while stakeholder engagement is recognized as important for tool design and contextual relevance (Pardo et al., 2022), there is limited empirical evidence on how CA tools directly support the assessment of LOs and the translation of those assessments into localized, actionable improvements. This study addresses these gaps by examining the implementation of assessment processes supported by CA tools across two universities, focusing on how they facilitate the direct measurement of student LO attainment and inform evidence-based decisions that enhance program quality and student learning.

3. Methods

3.1. Study Design and Research Questions

This study aims to explore how CA tools support both the direct assessment of student LO attainment and the formulation of continuous improvement actions in higher education. To address these research objectives, we adopted a multiple case study design, which enables the examination of a phenomenon across different contexts that share common traits while also allowing for the identification of meaningful variations (Stake, 2006). In educational research, multiple case studies have been effectively used to investigate human-centred aspects of LA technology adoption (Hilliger et al., 2024; Kotorov et al., 2024). Specifically, we analyzed two university settings in Latin America that have implemented structured continuous improvement processes to meet program accreditation criteria.

This two-case approach is part of a broader research project that evaluates the usefulness of CA in supporting quality assurance and continuous improvement in higher education programs across diverse institutional contexts in Latin America. The project began with an in-depth study of LO assessment using CA tools in a single institution. The current manuscript builds on that foundation by incorporating a second case, with a twofold objective: (1) to understand how CA-supported LO assessment contributes to the generation of actionable insights (the focus of this paper), and (2) to explore stakeholder engagement and institutional conditions that influence the adoption of CA tools, which will be addressed in subsequent work.

By examining and contrasting empirical evidence from different roles and experiences in these two settings, this study provides a richer understanding of how CA tools are used to support LO assessment and continuous improvement. The

comparative design also allows us to identify both convergences and contextual differences in implementation strategies, assessment practices, and institutional support mechanisms (Eisenhardt & Graebner, 2007). The following research questions guided data collection and cross-case analysis:

RQ1: How do CA tools facilitate the direct measurement of student LOs across diverse higher education programs?

RQ2: In what ways do CA tools inform and support the formulation of continuous improvement actions within higher education curricula?

3.2. Cases Forming the Multiple Case Study

To develop our multiple case study, we followed Stake's (2006) guidelines, which emphasize the importance of defining the study's scope and focus. As aforementioned, our multiple case study focuses on two contrasting settings to compare contextual similarities and differences (Sarmiento & Wise, 2022): one higher education institution in Chile (U1–Pontificia Universidad Católica) and another in Costa Rica (U2–Instituto Tecnológico de Costa Rica). As shown in Table 1, these institutions differ in terms of administration regime, year of foundation, and faculty-student ratio. They also differ in the educational systems in which they are immersed. While both countries share certain features of their higher education systems, such as reliance on a national admissions system and a mix of public and private institutions, they diverge in several critical aspects. Chile operates under a more centralized governance model, with strong state control over admission policies and funding, as well as a mandatory accreditation system (Brunner & Miranda, 2016). In contrast, Costa Rica is characterized by greater institutional autonomy and comparatively higher public investment in education, with accreditation remaining optional for academic programs (Strah, 2020).

Although each institution has its own characteristics, both implement a structured, continuous improvement process in which CA tools play a central role (see Figure 1). These tools are designed to support the alignment between courses, assessments, and intended LOs by capturing, storing, and visualizing LO assessment data reported by instructors at the end of each academic period. The process begins with administrators (U1) and faculty (U2) mapping LOs to courses within the CA tool to ensure coherence between instructional goals and assessment practices. Faculty then assess student performance using a four-level rubric at U1 and a five-point scale at U2. The CA tools extract these results and generate visual reports: U1 displays the percentage of students meeting expectations, while U2 provides mean scores, standard deviations, and achievement rates. These visualizations serve as actionable inputs for collaborative program meetings, where faculty and administrators analyze results, identify areas for improvement, and document decisions for accreditation purposes (visualizations reserved for blind review). The insights generated by the CA tools inform updates to curriculum maps and adjustments to teaching and assessment strategies, all within the framework of institutional regulations. Academic advisory units further support the process by ensuring alignment between LOs and assessments and assisting with data interpretation. These structured workflows, supported by CA tools and institutional guidelines, provide a robust foundation for evidence-based decision-making and continuous improvement in teaching and learning.

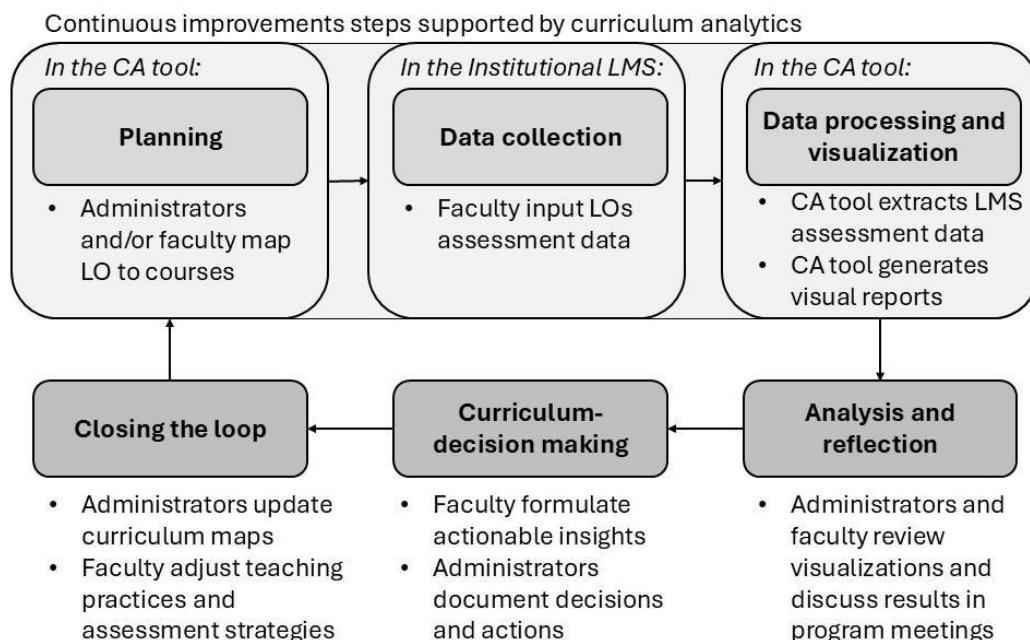


Figure 1. Continuous Improvement Process Implemented in Each Case Study Incorporating the Use of a CA Tool

Table 1. Case Study Features

Features	University 1 Pontificia Universidad Católica de Chile	University 2 Instituto Tecnológico de Costa Rica
Country	Chile	Costa Rica
Administration	Private (non-profit)	Public
Foundation	1890	1971
Student enrolment	30,000	40,000
Faculty members	1,500	871
Number of programs that use the CA tool	7	9
Accreditation agency	ABET (Accreditation Board for Engineering and Technology)	AAPIA (Agencia de Acreditación de Programas de Ingeniería y de Arquitectura)
Assessed learning outcomes	Problem-solving Design Communication Ethical responsibility Teamwork Data and experimentation Lifelong learning	Engineering knowledge Problem analysis Design Investigation Tool usage The engineer and the world Ethics Teamwork Communication Project management Lifelong learning

In both institutions, faculty and administrators are the main stakeholders involved in the continuous improvement process and are the primary users of the CA tools. Still, students benefit indirectly through evidence-based curricular decision-making. Further details about the specific context of each institution are described in the subsections below.

3.2.1. University 1

U1 has a long-standing commitment to international quality assurance through its accreditation with the U.S. Accreditation Board for Engineering and Technology (ABET). Since its first accreditation in 2007, the university has progressively expanded and redesigned its engineering programs, which now include eight ABET-accredited degrees. This ongoing accreditation and re-accreditation process has driven systematic curriculum redesign and continuous improvement initiatives, providing the institutional context in which the CA tools and assessment processes examined in this study were implemented.

To comply with this standard, U1 implemented a continuous improvement process to assess student skill attainment at the course level. In 2020 and 2022, the competencies evaluated included: (1) problem-solving, (2) design, (3) communication, (4) ethical responsibility, (5) teamwork, (6) experimentation and data analysis, and (7) self-directed learning.

Before the start of each academic period, teaching staff responsible for specific courses were required to plan a criteria-based assessment aligned with the curriculum map. This assessment used rubrics collaboratively designed with faculty, with criteria aligned to ABET accreditation standards. At the end of the semester, these results were converted to percentages of LO attainment to present them to the program chair and teaching staff at an end-of-semester meeting.

Between 2016 and 2017, about five managers and 160 teaching staff members were actively involved in all phases of the design and implementation of a CA tool. An Engineering Education unit led the tool development process, and it followed a design-based research approach. As shown in Figure 2, this tool allows managers and teaching staff members to collect and store program information (e.g., graduation competencies matrix and curriculum maps) and course-level evidence about student competency attainment (e.g., course syllabi and grading). To make LO attainment information readily available for curriculum discussions and staff reflection, this tool generates an automated report on competency attainment at a course level based on students’ partial grades in specific assessment methods (see Figure 3). The generation of this report requires teaching staff to indicate the relationship between program graduate competencies and course LOs and choose one or more course assessment methods to measure the attainment of the assigned outcome. In 2024, this CA tool was redesigned and integrated into the institutional LMS, so data was collected in this context to inform the development of this case study.

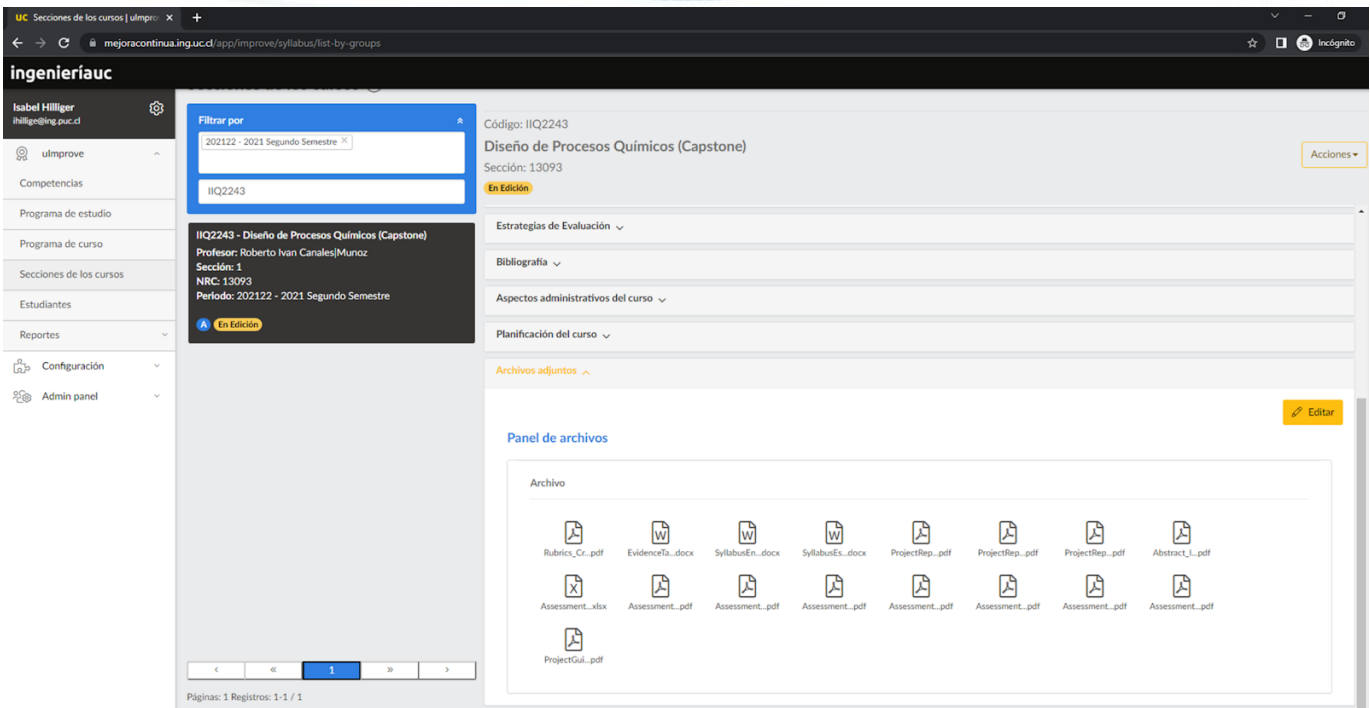


Figure 2. CA Tool Functionality to Store Course-Level Evidence Regarding Skill Assessment and Attainment

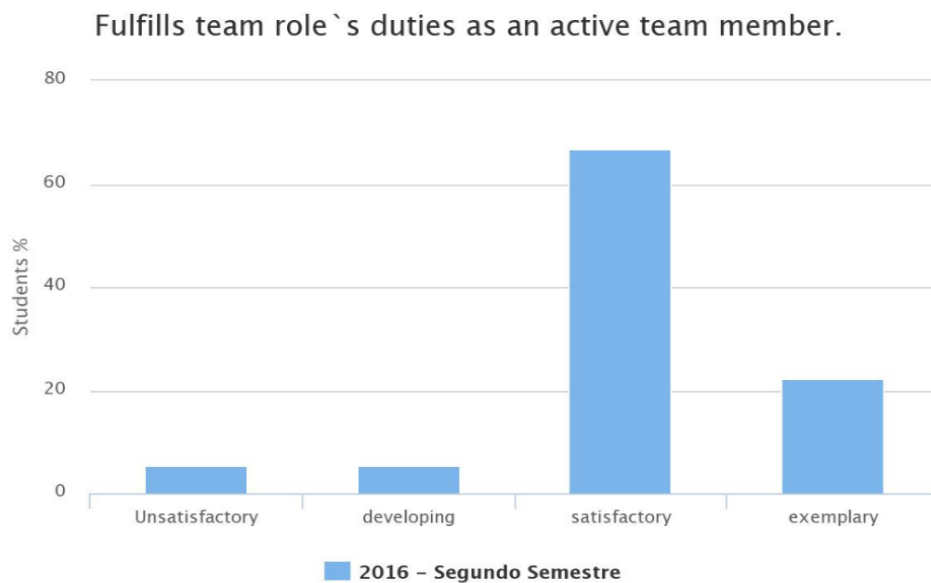


Figure 3. CA Visualization of LO Attainment According to Rubric-Based Assessment at a Course-level

3.2.2. University 2

In 2001, U2 began an accreditation process based on the standards of the Canadian Engineering Accreditation Board (CEAB), an international accreditation agency focused on continuous improvement. In 2022, U2 initiated a redesign process to assess LOs within the framework of accreditation by Agencia de Acreditación de Programas de Ingeniería y de Arquitectura (AAPIA), a national accreditation agency. Throughout this process, stakeholders were actively involved in all phases of the CA tool's design. This effort was preceded by the development of a methodology aligned with institutional regulations, clearly defining roles and responsibilities, and incorporating high-quality instruments, specifically, standardized scales for the direct assessment of the following LOs with valid and reliable metrics. The LOs assessed through curricula are engineering knowledge, problem analysis, design, investigation, tool usage, the engineer and the world, ethics, teamwork, communication, project management, and lifelong learning. To evaluate student evidence, instructors applied a 5-point numerical scale (1 = Does not meet the indicator, 2 = Achieves minimal compliance with the indicator, 3 = Meets the indicator but requires

opportunities for improvement, 4 = Meets the indicator, 5 = Exceeds expectations in meeting the indicator). These instruments were designed and validated in a previous study (Hernández-Campos, Prado-Calderón, et al., 2025). Instructors select a specific piece of student work (e.g., a homework assignment, presentation, or exam) as evidence to assess the LO mapped to the course. The scales are then applied by faculty to evaluate student performance in relation to the selected evidence.

Stakeholder engagement was a key element throughout the process. Developers of the CA tool worked closely with users, regularly gathering feedback and iterating on the design based on both user input and established design principles. The tool was designed for use across approximately nine engineering programs, serving 9,906 students and 153 instructors. This initiative was supported by a dedicated unit of academic advisors responsible for assisting faculty and facilitating communication with the development team. Figure 4 presents the outcome accomplishment visualization of the CA tool for faculty, including the LO acronym, number of students assessed, percentage of approval, mean, standard deviation, graphics, and observations made by instructors during the assessment process. Figure 5 presents a graphic of the LOs accomplishment.

Learning outcome	Course	Student	Excl.	Aprob.	Repro.	No Eval.	Evidenc.	\bar{X}	σ	% achievement	Improvement plan	Obs.	Graphics
DI (I)	1	26	0	6 (35%)	11 (65%)	9	9	2.57	0.08	35	Yes	70	
IN (I)	2	18	0	13 (76%)	4 (24%)	1	5	3.09	0.10	76	No		
AP (I)	3	9	0	5 (63%)	3 (38%)	1	4	3.00	0.03	63	No	40	

Figure 4. Outcomes Visualization From the CA Tool

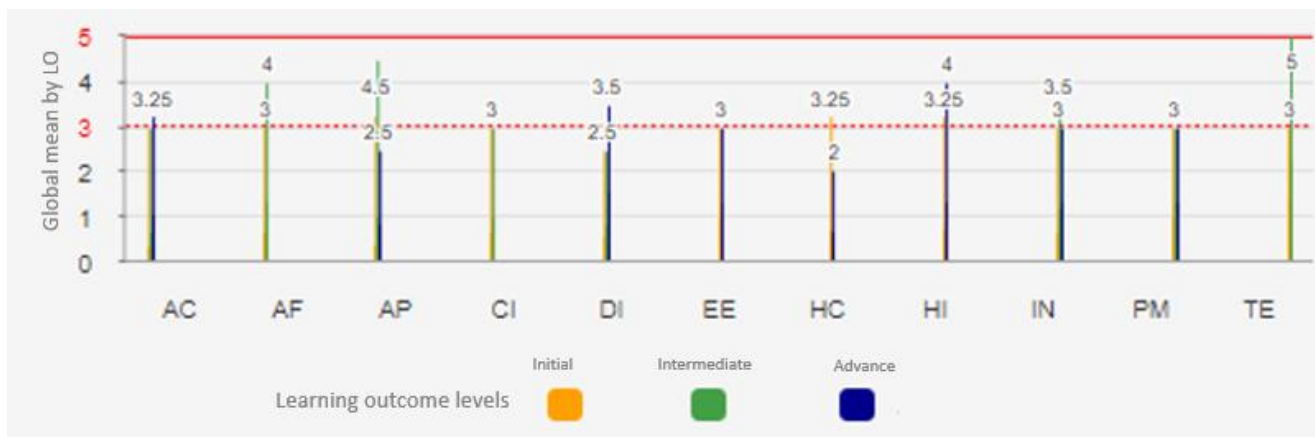


Figure 5. CA Tool-Generated Visualization of Average Achievement Levels for All Assessed LOs Within an Academic Program

3.3. Procedure and Data Gathering Techniques

The primary objective of employing a multiple case study design is to conduct cross-case analysis of findings from individual cases, facilitating the identification of both contrasting and convergent results (Eisenhardt & Graebner, 2007). To inform this cross-case analysis, we collected qualitative information from three primary sources: semi-structured interviews, cognitive walkthroughs, and document analysis. Table 2 describes the theoretical foundation that justifies why these data gathering techniques were chosen for this work, besides describing the purpose of using each one of them.

Table 2. Data Gathering Techniques

Data gathering technique	Theoretical foundation	Purpose
Semi-structured interviews	Semi-structured interviews are the primary source of data for constructing a case study (Mashuri et al., 2022). A minimum of six interviews per program is proposed, resulting in at least 12 participants. The interview protocol will be designed based on prior research by Hilliger, Celis, et al. (2022).	Faculty: Reflected on their role in the LO assessment process using the CA tool, its usefulness for planning improvements, its impact on students, and faculty engagement during course redesign. Academic advisors: Shared insights on the design of assessment methodology and tools, the use of data for driving improvements, specific program-level changes, and suggestions for enhancing the process. Developers: Described the development of the CA tool, including its conceptualization, design inputs, user requirements, and its functionality for coordinators and instructors (see Appendix 1).
Cognitive walkthrough	The cognitive walkthrough is a method for evaluating user interfaces. To conduct a walkthrough, a specific task supported by the interface is selected, and one or more correct sequences of actions for completing the task are identified. This method is used to detect interface issues and suggest possible causes (Lewis & Wharton, 1997). The protocol will be designed based on previous research by Hilliger, Celis, et al. (2022).	Participants completed a cognitive walkthrough using the CA tool, during which they were asked to identify interface features that support the formulation of improvement actions based on data visualization (see Appendix 2).
Document analysis	Documents are a crucial source of evidence for verifying and enriching other sources of information. Advantages of using documents include their stability, non-intrusive nature, accuracy, and broad coverage (Sebar & Vecchio, 2020).	Improvement plan reports for accreditation and institutional procedures related to LO assessment were analyzed.

Within the two settings described in Section 3.2, we chose convenience sampling to select the study participants who were directly involved in design, assessment, and decision-making using the CA tool at the selected universities. These key stakeholders include faculty, academic advisors (administrative staff), and platform developers (see Table 3).

Table 3. Main Information Sources for Each University

Data gathering techniques	U1	U2
Faculty interviews	5	6
Developer interviews	2	2
Coordinator interviews	1	1
Faculty-advisor cognitive walkthroughs	4	4
Improvement plan reports for accreditation	3	5
Presentations and institutional procedures related to LO assessment	2	2

This study was conducted under a protocol approved by the ethical commission of Pontificia Universidad Católica de Chile (protocol identifier number 241220001), in accordance with the ethical standards of the other institutions participating in this study. Identifiable data were removed, and the analyses were performed with non-identifiable data.

3.4. Cross-Analysis Plan

The analysis of the three sources of information described in Table 2 was done through evaluation coding with the support of Dedoose software (SocioCultural Research Consultants, 2025). This process entailed labelling pertinent sentences or ideas within documents or interview transcripts with specific codes (Saldaña, 2017). All interview transcripts and institutional documents were carefully read, and initial codes were assigned in Dedoose to capture evaluative meanings such as participants’ judgments, perceptions, and interpretations regarding the assessment and improvement processes. During the initial coding phase, two researchers independently coded a sample of the data. Then they compared their results in four cross-checking

sessions to ensure consistency and accuracy in code application. Interrater reliability was calculated to assess agreement, and any discrepancies were discussed until full consensus was reached. This iterative process led to the refinement of the coding scheme and the consolidation of 18 overarching themes (see Appendix 3). To enhance the credibility of the findings, triangulation was used to confirm that each theme was supported by evidence from at least two data sources in both institutional cases. This approach ensured that the final themes accurately represented convergent insights and minimized potential researcher bias.

Given that the multi-case analysis required multiple viewpoints (Stake, 2006), a peer-review process among three researchers was conducted to cross-analyze the 18 emerging themes. This analysis was conducted by a quality assurance specialist and two researchers specializing in technology-enhanced learning, each affiliated with a different university (one with a European university and two with Latin American universities involved in this multiple case study). This process involved evaluating the relevance of each theme in relation to each research question. To assess the importance of each theme, Stake (2006) proposes the following notation: H = high importance, M = medium importance, and L = low importance. In essence, the importance of each theme was determined by the extent to which it informs researchers about the functioning of the case study. The ranking of findings was performed using Fleiss’s Kappa index. Fleiss’s Kappa (Brennan & Prediger, 1981) was employed to determine the level of agreement among experts regarding the importance of each finding (H = high importance; M = medium importance; L = low importance) (Randolph, 2008). Only themes with full agreement among researchers regarding each research question were included in the following section.

4. Results of the Cross-Analysis

This section presents the key findings from the cross-case analysis conducted to address each research question, with a particular focus on the themes that reached full consensus among judges during the peer review process. Out of the 18 themes that emerged from the coding process, three were highly important to address research question 1 (RQ1) and six to address research question 2 (RQ2), all demonstrating perfect inter-judge agreement ($\kappa = 1.00$, 95% CI [1.00, 1.00]). These themes were selected for in-depth analysis in the following subsections.

4.1. Research Question 1

In our exploration of RQ1, which examines how CA tools facilitate the direct assessment of LO attainment across diverse higher education programs, we identified three main findings highly relevant to addressing this question (see 4).

Table 4. Results of Cross-Analysis Regarding Research Question 1: How do CA tools facilitate the direct measurement of student LO attainment across diverse higher education programs?

Final results of cross-analysis Key findings	Supporting evidence		
	Code used to categorize data	Sources	Number of extracts per code by university
Finding RQ1-1: The assessment and visualization of LOs through the CA tool facilitate the provision of targeted feedback to students and enable instructors to adjust their pedagogical practices based on evidence. This data-informed approach contributes directly to the continuous improvement of teaching and learning processes by making student performance more transparent and actionable.	Improvement actions	Documents (improvement report and methodologies) Interviews and Cognitive Walkthrough (faculty, academic advisors, developer)	$n = 46, 42.6\%$ (U1) $n = 62, 57.4\%$ (U2)
Finding RQ1-2: The LO assessment process, supported by the CA tool, positively influenced course design, pedagogical strategies, and assessment instruments. Faculty reported that the use of standardized rubrics and visual analytics promoted more authentic, participatory, and contextually relevant teaching practices. The process also encouraged reflective teaching, leading to adaptations in course content and the adoption of active-learning methodologies to enhance student skill development.	Related to the assessment process	Interviews and Cognitive Walkthrough (faculty, academic advisors)	$n = 7, 30.4\%$ (U1) $n = 16, 69.6\%$ (U2)
Finding RQ1-3: Faculty highlighted that the clear assignment of roles and the availability of training resources facilitated the effective implementation of the continuous improvement process supported by the CA tool. These organizational supports enabled more efficient evidence collection and analysis, while also fostering faculty ownership and acceptance of the process. As a result, instructors perceived a reduction in workload and an increased commitment to a culture of continuous improvement.	Well-defined roles	Documents (improvement report and methodologies) Interviews and Cognitive Walkthrough (faculty, academic advisors, developer)	$n = 12, 23\%$ (U1) $n = 40, 77\%$ (U2)

Note. The descriptive data were extracted from Dedoose.

The first finding indicates that the assessment and visualization of LOs through the CA tool enhanced students' learning experiences by enabling instructors to intentionally develop and assess both engineering and professional competencies, including 21st-century skills such as collaboration. To meet accreditation requirements, administrators and faculty used the CA tool to map LOs across the curriculum. Once this mapping was completed, instructors adapted their teaching strategies to integrate the assessment of professional LOs alongside technical content. The CA tool facilitated this process by providing structured, rubric-based input and visual feedback, which helped instructors monitor student progress and adjust their practices accordingly:

"We had to update aspects of the course to assess the learning outcome related to teamwork in a basic science course through a project-based learning. Typically, the course I teach is very theoretical and abstract, so it's stimulating for students to apply basic concepts in a simple, practical way. They not only learn to work in teams but also to apply abstract ideas in more tangible contexts" (instructor U1 regarding finding RQ1-1).

Once faculty assessed LOs in the LMS, they could track their students' LOs in the CA tool. They recognized that CA provides valuable input for tracking the development and progress of these competencies across different levels:

"I believe that the results from competency assessments are valuable on multiple levels. They provide a historical record at the program level but also offer insights at the individual faculty and student levels. With this data, we can track the development of skills and competencies, whether linked more to a specific course or the program as a whole, by monitoring the progress of different cohorts across various specializations. This, in turn, helps improve courses. Additionally, it allows students to become more aware of their learning and development process" (instructor U2 regarding finding RQ1-1).

The second finding reveals that faculty recognized the CA tool's role in prompting reflection on teaching practices and supporting continuous improvement. Through the institutionally defined assessment process, instructors entered LO attainment data into the LMS, which was then visualized via the CA tool. These visualizations were used in program-level meetings where faculty and administrators collaboratively analyzed results, proposed instructional changes, and documented decisions to support accreditation efforts. The CA tool thus served as a bridge between assessment data and actionable pedagogical decisions, reinforcing its role in the direct measurement and use of student skill attainment data:

"The evaluation process through the tool is valuable because it forces you to pause and reflect on whether your teaching methods and assessment tools truly demonstrate the achievement of the competencies you initially declared. So, I believe it's a good process to implement" (instructor U1 regarding finding RQ1-2).

In addition, planning, instructional strategies, and assessment approaches were seen to contribute to the development of life competencies in students, while also increasing their interest and motivation regarding changes in the courses:

"Personally, the assessment of LOs has been a major benefit for student learning. It prompted a shift from the traditional teaching and assessment approaches used in our courses. Previously, assessments didn't leave room for activities that truly encouraged life skills. This process made us realize the need for different kinds of evaluation activities that not only support the development of life skills but also help students learn technical engineering content. These new forms of assessment promote student self-reflection, and we've noticed that students are now more interested and motivated. Faculty have seen the positive impact these alternative assessments have had on the learning process and in their interactions with students" (instructor U2 regarding finding RQ1-2).

The third finding highlights the importance of clearly assigning roles and responsibilities to faculty, developers, and administrative staff in implementing the LO assessment process through the CA tool. In both institutions, this organizational clarity helped reduce workload and fostered a sense of ownership and value among participants. Faculty received logistical and technical support from academic advisory units, not only for conducting the assessments but also for using the CA tool effectively to map and visualize results. This support was instrumental in overcoming initial resistance to using the LMS for LO assessment and gradually increased faculty appreciation for the relevance of continuous improvement. Additionally, training opportunities and dedicated discussion spaces contributed to faculty engagement, empowering them to interpret assessment data and make informed decisions about curriculum and instruction:

"The competency assessment process has been a collective effort. For instance, the evaluation is distributed across multiple courses, instructors, and over time. What we were doing aligned well with expectations, as the accrediting agency requires us to carry out the evaluation and then, as a faculty group, come together to review the results and reflect on whether we're achieving our goals... We also ask ourselves: How can we improve for next time? One challenge, at least in our school, is that faculty are often overwhelmed with work. So, when something new comes along, the initial reaction is resistance, thinking, 'No, I don't want more to do...' But over time, you realize it's not as burdensome as it seems and, more importantly, that it adds value to student learning. Also, having support staff help with the evaluation process and use of the tool significantly eases our workload" (instructor U1 regarding finding RQ1-3).

Additionally, the availability of training opportunities in the assessment process, mapping, visualization of LOs in the CA tool, and dedicated discussion spaces contributed to faculty feeling more involved and empowered in the process:

"As part of the support for the evaluation process, we created a virtual space where everyone can access communications and materials related to the process. This allows faculty to consult information, ask questions, and stay informed as needed.

This initiative has been key to ensuring that everyone clearly understands their roles and deadlines. Additionally, short training sessions were held to explain the evaluation process, its importance, how to assess, and how to use the tool. These sessions were not just about training but also served as spaces for open dialogue where faculty could voice questions, concerns, and suggestions. This has led to faculty feeling more connected to and comfortable with the assessment process” (instructor U2 regarding finding RQ1-3).

At both universities, this institutional support helped reduce instructors’ feelings of overwhelm associated with implementing new processes in the context of accreditation.

4.2. Research Question 2

In relation to the second research question, we examined how CA tools inform and support the formulation of continuous improvement actions (see Table 5).

Table 5. Results of Cross-Analysis Regarding Research Question 2: In what ways do CA tools inform and support the formulation of continuous improvement actions within higher education curricula?

<p>Finding RQ2-1: Academic advisors from both institutions identified data visualization through the CA tool as a key driver of educational improvement. By making LO attainment data more accessible and interpretable, the CA tool positioned this data as the central axis of curriculum decision-making.</p>	<p>Improvement actions</p>	<p>Documents (improvement report and methodologies) Interviews and Cognitive Walkthrough (faculty, academic advisors, developer)</p>	<p><i>n</i> = 46, 42.6% (U1) <i>n</i> = 62, 57.4% (U2)</p>
<p>Finding RQ2-2: The integration of governance criteria and regulatory frameworks into the LO assessment process enhanced decision-making effectiveness. The CA tool supported this integration by providing structured evidence to facilitate informed decisions aimed at continuous improvement.</p>	<p>Related to outcome attainment</p>	<p>Documents (improvement report) Interviews and Cognitive Walkthrough (faculty, academic advisors)</p>	<p><i>n</i> = 12, 30% (U1) <i>n</i> = 28, 70% (U2)</p>
<p>Finding RQ2-3: Faculty and administrative staff acknowledge that the active participation and commitment of teaching staff were essential for the success of the LOs assessment process, supported by CA tools. Providing course instructors with concrete information and results enables them to visualize the impact of their work.</p>	<p>Stakeholder engagement</p>	<p>Documents (improvement report and methodologies) Interviews and Cognitive Walkthrough (faculty, academic advisors, developer)</p>	<p><i>n</i> = 6, 26.1% (U1) <i>n</i> = 17, 73.9% (U2)</p>

The judgment process revealed full agreement on six key findings. However, three of these findings were previously discussed in response to Research Question 1 and are not examined in detail again here. That said, it is important to emphasize that these earlier findings demonstrate the value of using CA tools to assess and visualize LOs within a structured continuous improvement framework. Specifically, the visualization of assessment data through the CA tool encouraged faculty to reflect on their teaching practices and identify areas for enhancement (see instructor excerpts from U1 and U2 related to RQ1-1). Importantly, these reflections translated into concrete actions: faculty reported increased use of active learning strategies, improvements in assessment design, and more intentional course planning. These changes contributed to greater student engagement and enthusiasm (see excerpts related to RQ1-2 and RQ1-3).

This alignment between assessment data and instructional improvement is echoed in finding RQ2-1, where academic advisors from both institutions noted that the assessment process had been redesigned with a clear focus on continuous improvement. After completing the assessment, faculty participated in structured meetings to analyze CA-generated data and make informed decisions about curriculum and instruction. This systemic integration is further evidenced by institutional practices that require faculty to review and adapt their teaching based on insights derived from CA visualizations:

“In previous processes, the focus was mainly on meeting accreditation requirements. But now, we want to strengthen internal dialogue. Our goal is to measure and develop an improvement plan and to follow up on its implementation” (academic advisor U1 regarding RQ2-1).

Although in both cases the CA tool is primarily used to support the assessment of LOs within the context of accreditation, the redesigned process explicitly incorporates the use of data derived from the CA tool to enhance the quality of the learning experience:

“The process we are currently working with is guided by a methodology that is clear, user-friendly, and well-structured. It outlines the steps and role, making it easy to follow. Compared to the previous approach, this methodology places greater emphasis on analyzing results and ensuring follow-up. When outcomes are positive, existing strategies are maintained. However, if improvement is needed, the methodology requires us to specify how those improvements will be implemented, including timelines and responsible parties” (Academic advisor U2 regarding RQ2-1).

According to the second finding, integrating governance criteria and regulatory frameworks into the assessment process via the CA tool supports informed decision-making for continuous improvement. Accreditation documents indicate that the administrative structure incorporates outcome analysis as part of this process:

“Table XX. Participants and Main Agreements from the Program Meeting held to Evaluate Student Outcome Attainment... A Program Committee meeting will be held at the beginning of the following year to evaluate all the results collected between the first semester, in addition to planning the next assessment process. This implies that the program has a systematic and sustainable continuous improvement process in place, relying on evidence of learning outcome accomplishment to inform curriculum renewal strategies” (U1 report regarding RQ2-1).

This systemic integration is further evidenced by institutional practices requiring faculty to review and adapt their teaching based on CA visualization data. Faculty were also expected to align course syllabi with the intended LOs:

“Additionally, based on the improvement opportunities identified during the review of course syllabi from the second semester of [year], the School Council (Session No. xx-xx), held on ‘date-year,’ approved a request for all faculty members teaching courses in the program to submit their course syllabi prior to the start of the second semester. This action aims to ensure that the syllabi include the corresponding learning outcome, as well as the activity or activities selected to assess it” (U2 report regarding RQ2-1).

Finally, both faculty and administrative staff emphasized the importance of instructors’ active involvement and commitment for the successful implementation of the LO assessment process using the CA tool. As highlighted in finding RQ2-3, providing instructors with clear, actionable data enhanced their engagement by allowing them to recognize the impact of their efforts and use this information to refine teaching practices and course design. However, this process unfolds gradually and depends on faculty genuinely valuing the assessment’s purpose. Institutional support mechanisms—such as training, technical assistance, and dedicated discussion spaces—played a critical role in fostering this engagement and building a culture of continuous improvement:

“Look, in general, the academic staff understands that this is important; they recognize that competency-based assessment is a key component of the educational process. I mean, the first time we carried out an evaluation, it was really challenging, mainly because we had to break the inertia, especially since we didn’t have a tradition of self-assessment. But then you realize that the process itself helps you form better students, because you start improving the course with the specific goal of developing the competency” (instructor U1 regarding RQ2-3).

In both cases, instructors initially experienced resistance due to the uncertainty and additional workload associated with learning a new process. However, once they realized they were not required to start from scratch and that only slight adjustments were needed, they began to feel more aligned with the process:

“I’ve found that evaluating learning outcomes through the platform has been very useful, because when we talk about learning outcomes, even if unintentionally, we end up using active learning strategies. This has made us more aware of how we teach. We also realized that there were things we were already doing quite well, like working extensively with projects and research, but we didn’t know these could be considered active learning strategies. So, I think one of the positive outcomes of this process has been recognizing that what we needed was to better structure our strategies and give clearer instructions, rather than start from scratch. As a team, realizing that we can improve our practice without drastically changing it has been very encouraging” (instructor U2 regarding RQ2-3).

5. Discussion, Implications for Practice, and Limitations

This study explored how CA tools support the direct assessment of student LO attainment and the development of continuous improvement actions in higher education, using a two-case study design grounded in replication logic. The findings contribute to the LA field by demonstrating how CA tools facilitate the assessment of LOs aligned with 21st-century competencies across two distinct institutional contexts. While recent studies have suggested that CA tools offer scalable methods for tracking and visualizing competency development (Barthakur et al., 2024; Divjak et al., 2025), this study provides empirical evidence of their practical application in authentic settings, demonstrating how they support the formulation of improvement actions.

Across both institutions, CA tools helped transform assessment data into actionable insights that informed program-level decisions. Faculty in both cases reported adopting more authentic, participatory, and contextually relevant teaching practices.

These changes were driven by structured reflection on LO attainment data, which led to adaptations in course content, assessment instruments, and pedagogical strategies. This convergence addresses a persistent gap in the literature between the intended purposes of LA and its demonstrated impact on continuous improvement processes (De Silva et al., 2024; Motz et al., 2023; Pardo et al., 2022; Schwendimann et al., 2017).

Despite these shared outcomes, the two institutions differed in how they implemented and supported the CA tools. At U1, the assessment process was tightly integrated into institutional governance structures, with a four-level rubric used to evaluate student performance and visualizations focused on the percentage of students meeting expectations. At U2, a five-point scale was used, and the CA tool provided more granular metrics such as mean scores and standard deviations. U1 emphasized compliance with accreditation standards and institutional alignment, while U2 prioritized pedagogical innovation and faculty autonomy. Taken together, these contrasts show that, despite differences in assessment instruments and reported metrics, both institutions fostered a culture of reflection on the data generated and shared a commitment to an evaluation process oriented toward continuous improvement, demonstrating how institutional context shapes the use and impact of CA tools.

The study also found that stakeholder involvement was critical in both cases but manifested differently. At U1, academic advisors played a central role in guiding faculty through the assessment process and interpreting CA visualizations. At U2, faculty-led initiatives and peer collaboration were more prominent. In both settings, providing instructors with clear, actionable data enhanced their engagement and fostered a sense of ownership over the improvement process. These findings align with prior research emphasizing the importance of sustained stakeholder engagement and data quality in achieving meaningful educational impact (Gray & Berner, 2022; Hilliger et al., 2024).

Another key insight is the role of CA tools in aligning LOs and assessment methods, particularly those related to 21st-century competencies. Instructors at both institutions reported that engaging with CA visualizations prompted deeper reflection on whether their assessments effectively captured the intended outcomes. This led to meaningful adjustments in course design and a shift toward more authentic, skills-oriented assessment practices. These findings resonate with Biggs's (1996) concept of constructive alignment, where teaching, learning activities, and assessment are coherently structured around intended outcomes.

Importantly, the successful integration of CA tools into institutional processes was supported by clearly defined roles and responsibilities for faculty, developers, and administrative staff. While both institutions embedded the tools within existing regulatory frameworks, U1 relied more heavily on centralized coordination, whereas U2 emphasized distributed leadership and faculty initiative. These differences underscore the need for flexible implementation strategies that account for institutional culture and governance.

In summary, this study offers practical and theoretical implications for higher education leaders, policymakers, and LA researchers. From a theoretical perspective, it addresses a significant gap in the literature by presenting concrete improvement actions generated using CA tools in two distinct institutional contexts. The findings underscore that fostering 21st-century competencies requires clearly defined LO assessment frameworks and tools that support both technical analysis and pedagogical reflection. Furthermore, in an educational landscape increasingly shaped by generative AI, the ability to meaningfully evaluate competencies depends on robust assessment infrastructure—such as that enabled by CA tools (Agbo et al., 2024; Radu et al., 2024). From a practical perspective, the study identifies essential institutional conditions for successful CA integration: clear roles and responsibilities; fostering interdisciplinary collaboration among faculty, administrators, and developers; and creating advisory units to guide analytic processes. These entities are key to ensuring consistent and informed use of analytics, supporting faculty in interpreting visualizations, and translating data into targeted improvement actions. In both institutions, stakeholder engagement and contextualized reflection throughout the assessment cycle proved fundamental to transforming data into pedagogical change.

The findings of this study should be interpreted in light of the following limitations. First, while this research contributes to the field of CA by providing empirical evidence on how the assessment of LOs can be translated into actionable insights across two authentic educational settings, it does not evaluate whether these insights directly lead to measurable improvements in student achievement or LO attainment. Second, the qualitative nature of the study, partially grounded in participants' experiences and perceptions, may introduce interpretive bias, despite efforts to ensure rigour through triangulation and multiple data sources. Third, the relatively short implementation period of the CA tools in both institutions may constrain the depth of observable impact and limit the generalizability of the findings.

6. Conclusion and Future Work

This study provides empirical evidence from two higher education institutions on how CA tools can support the direct assessment of LOs associated with 21st-century competencies and generate actionable insights for continuous improvement. The findings demonstrate that CA tools, when grounded in clear assessment frameworks and embedded within reflective teaching practices, enable faculty to interpret data meaningfully and connect it to pedagogical and curricular decisions. In doing so, they help bridge the gap in the LA field between LO assessment and its actual impact on learning experiences.

By integrating CA tools into institutional processes, both universities showed how analytics can function as catalysts for collaboration, reflection, and evidence-informed educational improvement. The use of a two-case qualitative design strengthens the credibility and transferability of these insights, demonstrating that the value of analytics emerges from the interplay among clear assessment frameworks, stakeholder engagement, and data use practices.

Importantly, the study highlights that generating actionable insights from CA tools depends on clearly defined institutional procedures that guide curricula and pedagogical practices in shaping competency development. Future research should examine the long-term effects of CA integration across diverse educational contexts and explore how individual and organizational factors mediate the interpretation and application of CA data. Further investigation into strategies for strengthening stakeholder engagement will also be essential to sustaining a culture of continuous improvement and advancing the meaningful use of CA in higher education.

Declaration of Conflicting Interest

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Appendix 1. Interview Protocol - Case Study

Pre-Interview Explanation: We are conducting a study aimed at exploring the usefulness of curriculum analytics in measuring learning outcomes and informing improvement actions in higher education. Given your involvement in learning outcomes assessment within quality management processes, whether as a faculty member, program director, curriculum coordinator, quality manager, or as part of the tool development team, we would like to hear your perspective. Your responses will be used solely for research and management purposes. All information collected will be handled confidentially. The interview will last approximately one hour. If you agree to participate, we would appreciate your consent to record the interview. Your participation is voluntary, and you may stop the interview or the recording at any time.

Following Consent Signature

As context, could you briefly describe your experience in the School of Engineering, both as a faculty member and in management roles?

What tasks were you responsible for in the Continuous Improvement process? What role do faculty members play in this system?

What impact does the continuous improvement system have on students? How does it contribute to course improvement?

What impact does faculty involvement have on this system? What about the role of program heads? And teaching assistants?

How important is it to encourage the involvement of faculty and students in this system? What could the school do to promote their engagement?

What aspects of this system do you think should be improved?

Thank you for all the information. Is there anything else you'd like to add that we haven't asked about but that you believe would be important to consider?

Appendix 2. Cognitive Walkthrough Protocol With Faculty and Managers

Objective:

To evaluate the usability and perceived usefulness of an analytics tool for measuring and visualizing learning outcomes.

Target Users:

Faculty members who have used the tool at least once during the past semester.

Context Questions

What role did you play during the accreditation process?

What has been your experience or interaction with the analytics tool for measuring and visualizing learning outcomes?

Activities

The facilitator will conduct a live demonstration of the tool, showing how LOs are defined, how they are linked to study plans and courses, and how achievement of competencies is visualized based on course grades.

Observe faculty and managers' reactions during the demonstration.

Questions to Assess Usability and Usefulness

Do you find the tool easy or difficult to use? Why?

What types of decisions or actions would you take based on the information reported by the tool?

What features do you think the tool is missing? What kind of information would you expect it to include?

Do you have any additional suggestions regarding the system, its visualization, data, or functionality?

Appendix 3. Coding Scheme

Table A1. Coding Scheme

Coding Scheme				
Category	Code-theme	Definition	When to use it	Example quote
Stakeholder engagement	Well-defined roles	When heads, academic advisors, instructors, and coordinators effectively fulfill their roles.	When the effective execution of the roles of academic advisors and coordinators contributes to the assessment process and continuous improvement.	I think we started doing that around 2015. Since then, the person who has led this effort in practice has been the "academic advisor." She has been the one guiding both the efforts within each course and, at the school level, promoting its value and feasibility.

Category	Code-theme	Definition	When to use it	Example quote
	Institutional support	When instructors receive institutional support.	When instructors receive support from academic advisors, heads, coordinators, or technical assistance.	So, from the coordination side, it's always about addressing questions and observations on rubrics, tools, and improvement plans proposed by faculty, and reflecting those in the report.
	Effective governance	When the process has been supported by regulations and formal procedures.	Examples of how formal procedures support the continuous improvement process.	We end up doing it, we set deadlines and carry things out through the council. A report is produced. The LOs report couldn't be completed because some parts are still under review. We urge that everything be reviewed before a specific date, and it's recorded in the meeting minutes. We check who submitted and who didn't. Typically, everything gets done on the last day.
	Faculty perceptions of value	When faculty members recognize the value of the process.	Comments related to the value of LO assessment for continuous improvement or comprehensive education.	The thing is, if a student clearly understands the LO that a course focuses on, they'll eventually realize that each course emphasizes different attributes. And that can give them a better, more complete picture of what they need to improve in terms of their skills, it gives them a broader perspective on their abilities. Maybe when we're in that stage of being students, we're not entirely sure what the desirable skills are, right? But if you can see the full picture and notice that different courses highlight different attributes, even if they're just briefly mentioned, you start to develop an awareness of the various attributes it's good to have skills in.
	Student engagement	When participants highlight the importance of recognizing students as key stakeholders in the learning analytics process.	Comments related to the importance of recognizing students as key stakeholders in the learning analytics process.	I feel like there isn't much awareness on their part because they don't see it. In the LMS, students don't see whether what they've submitted is going to be evaluated based on a specific LO; that's something only the professor sees in the course settings. So, it's not visible to the students. I think that's an area for improvement, making them actually feel like they're being evaluated on that LO. Right now, students don't see it; there's nothing visible to them. And from what I understand, the attribute manager still doesn't reflect that information back to them; it doesn't get updated for them.
Stakeholders disengagement	Usability issues	When instructors and coordinators encountered usability issues that hindered the assessment process.	Comments related to how usability issues hindered the assessment process or their perception of usefulness.	You must go through the whole process because LMS, when it comes to group assignments, doesn't let you assign different grades to individual students. So, many professors don't use the grouping feature because it forces them to give everyone the same grade. And that's not always fair, because there are self-assessments and peer evaluations. The professor might evaluate individual performance, and someone who didn't contribute or do anything would still get the same grade. So, at least here in the school, professors don't like using that Tec Digital feature. And if that feature isn't used, then when you upload the attribute or the evidence for group evaluation, it only gets assigned to one person.
	Overload	When they perceived an overload of responsibilities.	Comments related to the overload of responsibilities that hinder the continuous improvement process.	...you can't expect a single course to cover all the competencies, because that would be overwhelming; it would basically crush them. So, it must be distributed as evenly as possible, with the workload spread across multiple courses, multiple

Category	Code-theme	Definition	When to use it	Example quote
				professors, and over time. Not all in one semester, but rather over a couple of years, maybe two or three. So, we try to move in that direction.
	Other factors that promote disengagement. For example, the process is not valuable	When participants report other factors that promote disengagement with the process.	Comments related to other factors that promote disengagement with the assessment process and continuous improvement (the process is not valuable).	It's been an issue that not all professors are convinced that this process is truly valuable.
	Instructors don't know how to carry out the evaluation	When participants report that faculty don't know how to evaluate the competence or attribute.	Comments related to faculty difficulties assessing an attribute or competence.	I feel that when everyone gets a three, or a five, or even when everyone fits neatly into the bell curve, that doesn't really tell us whether our activity that's meant to foster communication is meeting the standards, right? The standards set by the accrediting body or bodies. There's also this culture, several professors have told me the same thing: "But XX, how do I know if I'm doing it right?" And I tell them what the "support office" told me: "You are the experts." And I think that's part of the issue, too. Even though they are experts, they're so overwhelmed, so overloaded, that maybe they're not putting as much care into it as they could. So that's where the problem lies. Because if you tell me, "Well, let's give them a training session," you're going to lose them. It's a tricky situation.
Definition of LOs	Assessment subjectivity	When participants perceive the assessment of LOs as subjective.	Participants' comments related to the subjectivity of assessment.	Whether the level is beginner, intermediate, or advanced, the question is whether it aligns with what the students expected. This has raised some doubts, because since it depends so much on the professor's judgment, they feel it can be subjective in some cases. Depending on the evaluation evidence used, if it's an exam, for example, it might be more objective. But if it's something like an essay, a project, or an open-ended solution, then it becomes harder to evaluate objectively.
	Assessment tools design	When participants describe the design process of the assessment tools.	Comments describing the design process of the assessment tools.	The design of assessment tools was a slow process, a lot of work; we had to meet and really think things through. Like, "Okay, let's see, this competency, for example, the one related to experiments, can be broken down into being able to design an experiment, being able to carry out an experiment, and being able to interpret the results of that experiment." And for other competencies, we tried to define two or three indicators. On top of that, we also defined levels of achievement for each of those indicators, typically in three levels: not achieved, basic/intermediate, and well achieved, something along those lines. We took our time to define everything as precisely as possible. We're kind of obsessive here in our school; if we don't define things clearly, anything can happen later. So, we have to be very, very rigorous with the definitions.
Improvement actions	Related to the assessment process	When participants discuss	Comments related to improvement actions resulting from the	Well, in terms of usefulness, I find it very valuable because when we talk about LOs, even if we don't intend to, we end up using active learning

Category	Code-theme	Definition	When to use it	Example quote
		improvement actions resulting from the assessment process that are not directly based on the outcomes.	assessment process that are not directly based on the outcomes.	methodologies. So that’s made us realize that, in fact, we were already doing a lot of things well. We were already working a lot with project-based learning, doing a lot of research-based work, but we didn’t know that those were actual methodologies, that there were structured approaches based on those practices. So, I think one of the good things that’s come out of the LO assessment process using the LMS is that it’s helped us recognize that we were already using active learning methodologies. Maybe they weren’t fully structured or aligned with best practices, but we were already doing them.
	Related to outcome attainment	When participants discuss improvement actions informed by the outcomes.	Comments related to improvement actions informed by the outcomes.	We’ve improved the course descriptions and the entire operational side of things, with better instructions, clearer procedures, and more defined schedules. Before, it wasn’t so common to have a timeline. The professor might have had everything planned out, but they would go session by session. Now, because of the need to implement more structured active learning methodologies, they have a more organized course plan, which is clearly reflected in the course syllabus. So now there’s a much better operational structure in place.
Challenge of assessing competencies (This category examines the balance between technical and professional skills, the global complexity of assessing competencies, and the contrast between competency-based and content-driven teaching paradigms)	Technical versus professional skills	Participant refers to the difference regarding assessing technical versus professional skills (e.g., teamwork, ethics, etc.).	Comments related to the challenge of assessing technical versus professional skills.	The agency calls them “student outcomes,” and gradually, or maybe even before, but we hadn’t done it ourselves until around 2014, when the agency visited us, they said, “Okay, what you’re currently assessing are the specific technical competencies declared in each course. But we want you to also assess these broader competencies, the student outcomes.” We’ve since defined them a bit more because we believe they’re beneficial for the entire engineering community. So, they’re not specific to any one discipline; they’re common to all engineering students, across all programs. These included things like communication, staying continuously updated in one’s field, teamwork, and so on. All those competencies were already defined as transversal, meaning they apply to every engineering discipline. Any engineering program should aim in that direction.
	Importance of competence assessment beyond its context	The participant notes that the assessment process and analysis of LOs are important beyond their context.	Comments related to the fact that the assessment process and the analysis of LOs are important beyond the educational context.	Interviewer: Well, we know that the agency evaluates competencies like ethics, communication, teamwork, and lifelong learning. How has the process been in the case of those competencies? Because it’s different from the more technical engineering competencies, since the instructors are engineers. How have you addressed those more professional or transversal competencies? Interviewee: Yes, exactly. What we’ve done, essentially, is define something relatively precise for each of those. For example, in the case of ethics, it involves students being presented with a situation that includes some kind of ethical dilemma. There are certain courses where those kinds of scenarios naturally come up.
	Competency-based versus content-driven	Participants discuss the distinctions between a		I think maybe we brought it up at some point, but we quickly realized that, in practice, we’ve always been doing it; we just weren’t fully aware of it. For example, a long time ago, when the school shifted

Category	Code-theme	Definition	When to use it	Example quote
	teaching paradigms	competency-based educational approach and a content-focused educational approach.		<p>from evaluating courses based solely on content to a more competency-based approach, as it's called today, group work became a key part of almost every course. In our department, we take that very seriously. It's a discipline where this kind of work is very feasible.</p> <p>But in our discipline, students can absolutely work on group developing projects. So, we quickly moved to a model where all courses, in addition to having exams that assess the more theoretical aspects, also include group assignments, either monthly or semester-long. And through those group projects, students naturally engage in teamwork and communication, especially since they also must give presentations.</p>
Tool design process	Tool features	The tool's characteristics are discussed.		<p>Interviewee: When I arrived, the promise was that the CA tool would be integrated into the LMS. So, when I joined, they were trying to build that integration, but it never materialized.</p> <p>Interviewer: And why? I mean, why do you consider it important?</p> <p>Interviewee: Integrating with it would make continuous improvement more effective, and the platform would be much more usable in the academic context. Professors already use the LMS all the time, so pulling information from there would mean a lot of things are already integrated; we wouldn't have to duplicate or overwrite what's already in use.</p>
	Stakeholder involvement in the design process	The tool design process is described.		<p>When I joined the project, we already had documentation explaining how professors should work with competencies, but the digital tool to support that process still needed to be built. So, we formed a large, multidisciplinary team—including developers, designers, professors, and pedagogical advisors—and held long, detailed sessions to define every step of the process: who would do what, how, and when.</p> <p>We created a comprehensive document and worked closely with the LMS team to design a clear system architecture. This included defining responsibilities, how information would be entered and viewed, and how the platform would function overall. What made the difference was the strong collaboration between technical and academic teams. The LMS team didn't work in isolation—they involved us throughout the process.</p> <p>Now, thanks to that strategic partnership, professors and coordinators can use the platform effectively and access everything they need in one place.</p>