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# Supporting Decision-Making for Promoting Teaching and Learning Innovation: A Multiple Case Study

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## Abstract

The quality of the data and the amount of correct information available is key to informed decision-making. Higher education institutions (HEIs) often employ various decision support systems (DSSs) to make better choices. However, there is a lack of systems to assist with decision-making to promote innovation in teaching and learning. In this study, we evaluate an analytic tool called PROF-XXI that supports strategic decision-making of teaching and learning centres (TLCs) by identifying their competencies in teaching and learning innovation. Through a multiple case study conducted with three Latin American universities and supported by quantitative and qualitative data, we observed how this tool is used and how it facilitates strategic decision-making. Our findings indicate that the tool is accessible, user-friendly, and effective in 1) initiating identification and systematic reflection of institutional competency levels in teaching and learning innovation, 2) enhancing understanding of strengths and weaknesses as well as identifying opportunities for innovation, 3) supporting TLCs with short- and long-term decision-making, and 4) continuously evaluating their strategies, programs, and initiatives. This research can benefit policymakers in higher education who are involved in measuring institutional competencies to improve teaching quality or in making strategic decisions related to teaching and learning innovation.

## Notes for Practice

- The PROF-XXI tool offers TLCs the ability to make informed decisions by providing interactive dashboards and comprehensive visualizations.
- The PROF-XXI tool empowers TLCs to track key performance indicators, monitor progress, and effectively plan for the future.
- The PROF-XXI tool supports evidence-based decision-making for teaching and learning innovation and can benefit those who aspire to develop tools of similar nature.
- The PROF-XXI tool can be used as a self-assessment tool for accreditation and certification purposes for TLCs in Latin American countries.

## Keywords

Decision-making in higher education, teaching and learning centres, dashboards, data-driven decisions, learning analytics, analytics tools

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## 1. Introduction

Disruptions, becoming commonplace in these times, compel higher education managers to find non-trivial solutions (García-Morales et al., 2021; Kotorov et al., 2021). For example, COVID-19 wreaked havoc on the operations of HEIs worldwide

(Krasylnykova et al., 2023; Mazzara et al., 2022), forcing their leaders to adopt digital technologies on an emergency basis (Chick et al., 2020; Kotorov et al., 2023) and make a string of other decisions. However, many disruptions, from political to financial to environmental, can affect HEIs in similar ways.

Traditionally, higher education institutions (HEIs) rely on teaching and learning centres (TLCs; Atkins et al., 2017) when it comes to strategic planning and development decisions. TLCs are support units within HEIs that can drive sustainable change (Gray & Radloff, 2006), develop strategic directions for the digitalization of sustainable educational processes, define the required competencies for staff and students (Moya et al., 2019), and introduce innovation in pedagogical strategies and institutional practices (Palmer et al., 2010). To enhance this strategic decision-making and benefit from the data amassed within these increasingly digitized institutions, HEIs have shown a heightened interest in the use of decision support systems (DSSs) (Bresfelean & Ghisoiu, 2010; Bugwandeen & Ungerer, 2019), defined as “knowledge-based information systems to capture, handle and analyse information which affects or is intended to affect decision-making performed by people in the scope of a professional task appointed by a user” (Bresfelean & Ghisoiu, 2010, p. 44).

The use of DSSs in the education sector “has rapidly increased due to their accuracy, efficiency and effectiveness” (Shah, 2014, p. 2799). They are acclaimed for their ability to extract institutional data, expediting decision-making in administrative and academic domains (Rippen, 2005), all the while contributing to the enhancement of efficiency and productivity (Shalabi, 2020).

Bresfelean and Ghisoiu (2010) proposed a widely accepted classification of DSSs employed in HEIs based on three modules — students, teaching, and research — and the type of decision situation involved (Table 1). These DSSs usually collect information on all academic and scientific processes, provide feedback for their improvement, and offer decision-making support at the student, teacher, and researcher levels.

**Table 1.** Decision Support System Modules in HEIs  
(adapted from Bresfelean & Ghisoiu, 2010)

DSS Module	Students Module	Teaching Module	Research Module
<b>Decision Situations</b>	• Student enrollment	• Syllabi and teaching materials	• Scientific research evaluation
	• Tuition	• Course and exam schedule	• Performance issues and standards
	• Specialization(s)	• Choosing optional courses	• Salary coefficients
	• Scholarships	• Tutoring activities	• HR strategy
	• Dorms	• Teaching-learning activities	• Job openings and interviewing for research positions
	• Issue Certificates	• Students’ practical work	• PhDs’ activity and evaluation
	• Announcements	• Preparation for exams	• Grants’ continuation and management
	• Student transfer	• Evaluation of teachers	
	• Expelling students	• Partial exams during the semester and final exams	
	• Interruption of studies	• Student grading	
	• Extension of studies	• Contestation of the results	
	• Tutorial activities	• Final exams	
	• Career Guidance		

A recent review by Cubukcu Cerasi et al. (2022) revealed that most efforts had been put into designing educational DSSs that are either student-/instructor- or management-centred. Student-/instructor-centred DSSs focus either on supporting students in their learning journey and enhancing their educational experience (Almeida & Amoedo, 2018; Chanwijit et al., 2016; De Laet, 2023) or aim at improving learning processes and instructor performance (Oliva-Córdova et al., 2021; Quadri & Shukor, 2021). Management-centred DSSs are commonly dealing with general aspects of higher education administration and support existing institutional processes (Kasap et al., 2020; Nieto et al., 2019a; Ploywattanawong, 2016). However, existing DSSs do not adequately address institutional strategic planning and development (Fakeeh, 2015; Nieto et al., 2019b), meaning that there is a lack of systems designed to aid TLCs or similar strategic units in making informed decisions about complex processes, such as innovations in teaching and learning or strategic planning and development (Albon et al., 2016; Atkins et al., 2017).

This paper zeroes in on the analysis of the PROF-XXI tool (Kotorov et al., 2022), a DSS designed to assist TLCs in their decision-making and improve their decision-making capabilities about teaching and learning innovation. Specifically, this paper aims to analyze the use of this tool as a solution for informing HEI staff and decision-makers from three Latin American institutions about the evolution of their institutional digital competencies, thus increasing their potential for driving innovation in teaching and learning.

## 2. The PROF-XXI Tool: A DSS for Teaching and Learning

The PROF-XXI tool<sup>1</sup> is one of the results of the European PROF-XXI project that aims to help TLCs meet the challenges of the 21<sup>st</sup> century (PROF-XXI, n.d.) and facilitate their development and self-assessment of competencies. The tool is based on the PROF-XXI competency framework, which offers a robust and holistic perspective on the competencies that TLCs should develop to support a deep and sustainable transformation of HEIs. The framework describes “the competencies that TLCs should consider for defining strategies and actions allowing for support of teaching and learning innovation” (Pérez-Sanagustín et al., 2022, p. 3). It defines 50 interrelated competencies organized into five dimensions: 1) teacher support, 2) student support, 3) leadership, culture, and transformation, 4) technology for learning, and 5) evidence-based practices. For each dimension, it defines a set of competencies that TLCs should achieve organized into five levels: 1) development, 2) innovation, 3) value generation, 4) new challenges and opportunities, and 5) public accountability of impacts for continuous improvement (Kloos et al., 2021). The PROF-XXI tool uses this framework as a basis for systematizing the evaluation of competencies, allowing TLCs to explore the decision environment and consider weaknesses and opportunities from more dimensions. Its objectives are to meet the needs of TLCs and empower them to measure the impact of their teaching and learning innovation strategies with better decision support than ever before.

The website-based PROF-XXI tool offers an extensive range of functionalities designed to meet the diverse needs of educational leaders and stakeholders. Notably, it allows for the creation of units of analysis, providing a structured approach for understanding the competencies of various groups within the institution, whether academic departments or stakeholders. This facilitates targeted assessment and improvement efforts. The tool’s scan creation feature generates unique URLs for questionnaires that can be sent to a particular population within the institution, simplifying the process of gathering essential data for competency evaluation. The questionnaire administration component includes 50 competencies aligned with the PROF-XXI framework and enables participants to express their perspectives on competency levels using a carefully defined scale. The PROF-XXI tool’s monitoring area offers a dedicated space for assessing institutional performance and competency development, granting valuable insights into how competencies evolve over time. Units analytics, university analytics, and global analytics further enhance the tool’s capabilities by allowing for in-depth comparisons, benchmarking, and performance evaluation. The tool provides a space for storing and tracking different initiatives developed by institutions and a comparative analysis of initiatives among institutions to support decision-makers in defining the institutional strategy for teaching and learning innovation. It collects data about the institutional teaching and learning competencies from students, teachers, and managers through specific questionnaires and provides a set of dashboards displaying the competency level of the institutional departments or units. These dashboards are interactive, which allows decision-makers to navigate the different competencies of the university departments or units, compare them and see what initiatives were more effective for their development. The ability to see the evolutionary development over time plays an important role in decision support (Kadoić et al., 2018). All indicators in these dashboards provide a snapshot of the institution units at a particular time that helps make decisions about which competencies to focus on for improvement. In addition, and if the institution allows it, this information can be shared with other HEIs for comparison. The possibility of benchmarking against other institutions helps to avoid myopia regarding the overall situation (Catino, 2013) when analyzing the level of competencies. The tool also serves as a place for searching other institutions’ initiatives and solutions to develop their teaching and innovation competency levels.

Figure 1 provides an example of some of the visualizations proposed by the tool, namely, General Competencies Overview: (a) a gauge showing the average grade of competency and (c) a radar showing the average level of competency; Data Sample: (b) a pie chart about the percentage of participants who completed the questionnaire; Stakeholder Perceptions: (d), (e), and (f) bar charts displaying information about the perceptions of different stakeholders of the different competence dimensions and levels, and their comparison; and Trends of Competencies over Time: (g) a line graph depicting the chronological evolution of competencies based on the average level registered at a specific point in time.

The architecture of the PROF-XXI tool as a web application is well thought out, combining server-side and client-side technologies to ensure efficiency and reliability. On the server side, the backend is built using NodeJS, a JavaScript framework known for its scalability and exceptional data processing speed, enhancing the tool’s performance for data handling and client-server interactions. This choice allows for smooth and rapid data processing, which is crucial for managing the extensive information related to competency assessments. The use of a relational database in MySQL further strengthens the web application’s reliability, providing a clear and straightforward data model, which is essential for the PROF-XXI platform’s usability and robustness. The client side, on the other hand, utilizes ReactJS, a JavaScript library that excels in delivering high-speed client-server interactions, complementing NodeJS on the backend. Notably, ReactJS empowers the creation of reusable UI components, enhancing the user experience by enabling consistent and dynamic dashboards for data visualization. These

<sup>1</sup> <http://141.115.26.76/>

architectural choices result in a well-balanced system, making the PROF-XXI tool a powerful and user-friendly platform for competency assessment and improvement.



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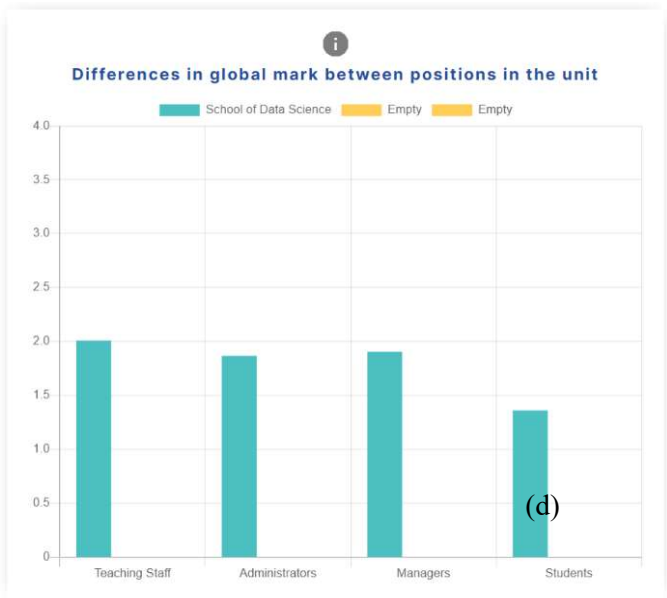
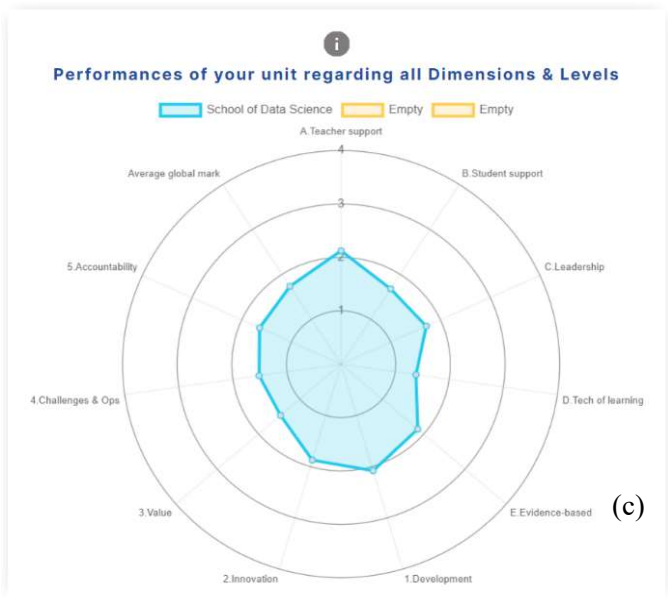
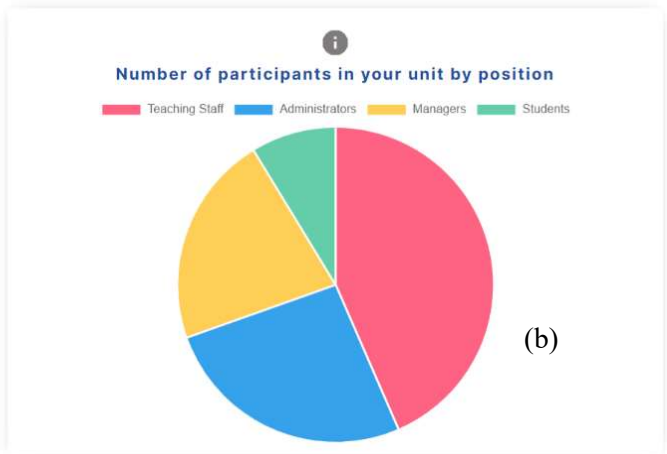
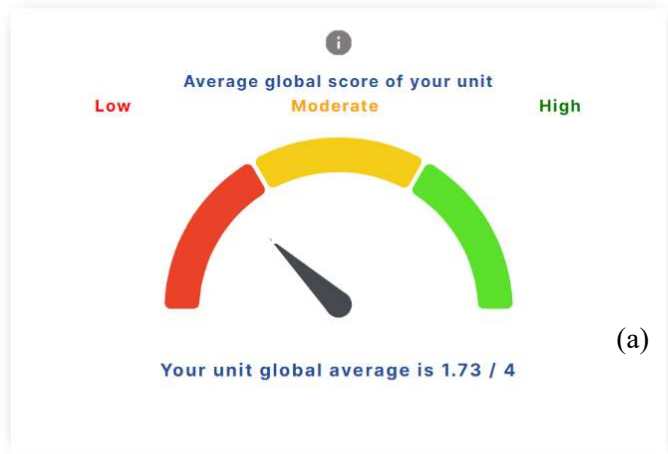



Unit Analytics

University Analytics

Global Analytics

Change Unit: School of Data Science



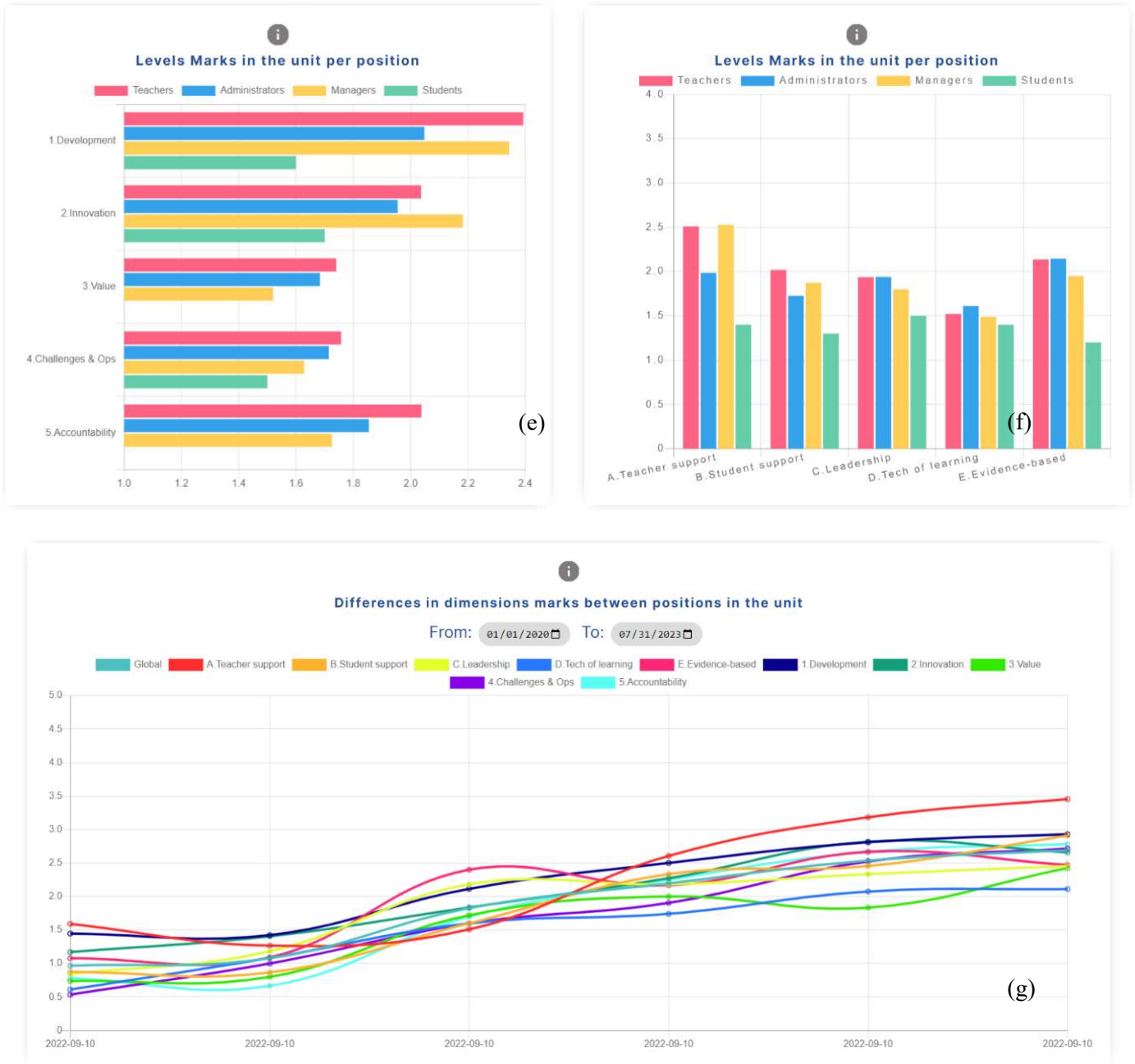


Figure 1. Dashboards provided by the PROF-XXI tool for the unit analytics.

### 3. Research Methodology

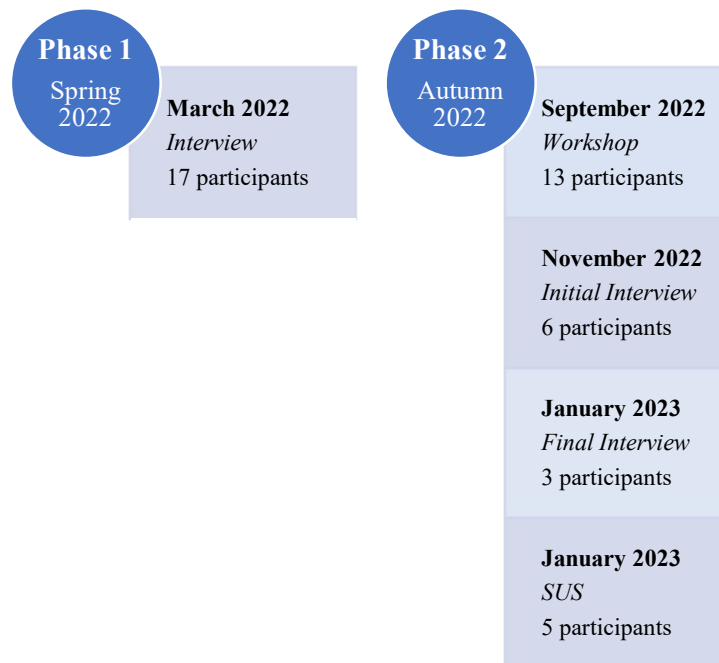
The main aim of this study is to analyze whether the PROF-XXI tool supports the decision-making process of TLCs. As a methodological approach, we chose a multiple case study of three cases in which we collected, analyzed and interpreted both qualitative and quantitative data from three different universities to understand the use of the PROF-XXI tool. While the case study method “explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information [...] and reports a case description and case themes” (Creswell, 2013, p. 97), the multiple case study allows researchers to analyze the varied contexts of the cases independently, compare them, thus expanding the generalizability of the findings and “strengthening their external validity” (Yin, 2003, p. 54). The analytic conclusions arising from the three cases will provide substantial support in confirming that institutions can use the PROF-XXI tool in the future as a decision aid (Eisenhardt, 1989). In addition, by employing a case study approach, we can thoroughly understand the tool’s dynamics and relevance within the specific case, thereby contributing

to the discipline’s broader knowledge and growth (Cohen et al., 2017). The following four research questions drove the data collection and analysis process:

- RQ1:** How is the PROF-XXI tool used in the institution, and for which purposes?
- RQ2:** How does the PROF-XXI tool support decision-making about the initiatives for the strategic development of TLC competencies?
- RQ3:** How have the decision-making processes been impacted/changed with the use of the PROF-XXI tool?
- RQ4:** How convenient are the PROF-XXI tool and the provided indicators in terms of usability?

**3.1. Procedure and Data Gathering Techniques**

To answer research questions 1 to 3, we designed and carried out a series of activities, divided into two phases (see Figure 2). Phase 1 concentrated on getting insights into the actual decision-making processes adopted in the universities selected for the case study. It included one semi-structured interview conducted with representatives of the institutions in March 2022. This type of interview lasts for about an hour and consists of closed and open questions (Galletta, 2013). Phase 2 focused on understanding the impact of the PROF-XXI tool on decision-making at the universities after its introduction. This phase took place from September 2022 to January 2023 and included one in-person workshop run in Toulouse, France, in September 2022, followed by one initial interview in November 2022 and one final interview in January 2023, followed by the System Usability Scale (SUS) conducted in January 2023.



**Figure 2.** The chronological arrangement of performed activities for data collection.

The workshop carried out in phase 2 consisted of four blocks: 1) a demo presentation of the PROF-XXI tool; 2) an open discussion about decision-making processes; 3) filling out the SUS; and 4) calendaring. During the first block, the facilitator introduced the PROF-XXI tool to the participants and explained its main characteristics for supporting strategic decision-making. Afterwards, the facilitator asked the participants to create an account and play with the tool for around 20 minutes. During the second block, the facilitator initiated discussions about the decision-making processes at the institutions by introducing the topic. Then, participants were asked to use digital post-its in Lucid.app to capture their current decision-making processes to determine which competencies their TLCs should develop (see [Appendix 3](#)). This activity was finished with a 30-minute open discussion about the decision-making processes grouped by the decision type. During the third block, the facilitator asked the participants to share their subjective assessments of its usability, based on first impressions, by filling out the SUS. The SUS is widely used as a quick usability measurement method and aligns with user preferences (Drew et al., 2018). During the last block, participants were asked to fill in a calendar and note possible actions and decision-making goals to track the tool’s usage in a natural context. The calendar indicated the schedule of questionnaire campaigns, i.e., when each TLC planned to launch a particular initiative to improve certain aspects of the teaching and learning innovation process and, therefore, use the tool to track the evolution of the competencies development.

It is important to note that the workshop primarily allowed participants to register and become acquainted with the tool, enabling them to explore its features and identify potential areas for improvement. Following the workshop, participants actively used the tool in their daily activities during the autumn semester of 2022 within the three universities, utilizing real-world data for decision-making.

According to the schedule defined by each institution in the calendar, we ran two interviews with each institution. All interviews were semi-structured. The objective of these interviews was to understand 1) how the tool was used, 2) how well the tool could support the decision-making process, and 3) whether there were any aspects to be improved.

To collect quantitative data and answer research question 4, participants were asked to complete the SUS questionnaire after the final interview. To ensure that the questionnaire was suitable for the Spanish-speaking participants, we used an already-validated translation of the original SUS questionnaire proposed by Sevilla-Gonzalez and colleagues (2020). However, we made some minor adjustments to make sure that the questionnaire was relevant and applicable to our specific context, which in turn allowed us to obtain more accurate and comprehensive feedback. We also added nine extra questions to the standard questions provided in the SUS to understand better whether the chosen indicators and visualizations support strategic decision-making.

The data collected during the process is summarized in Table 2, indicating the data source and its description, along with links to the original files used for data collection and the data collection protocols.

**Table 2.** Data Gathering Techniques

Data gathering technique	Description	Reference	Label
Interviews on actual decision-making processes	Information about the current decision-making processes adopted by the universities was extracted from a semi-structured interview conducted in March 2022.	See <a href="#">Appendix 2 (Supplementary Materials [SM])</a>	[Interviews_Decision-Making]
Workshop with the institutions' representatives of the TLC	Workshop in Toulouse, September 2022: Activities for introducing and initiating the tool for its successful testing over the following months.	See <a href="#">Experimental Protocol (EP)</a> See <a href="#">Appendix 3 (SM)</a>	[WS]
Calendar	Calendar with actions and decision-making goals.	See <a href="#">Appendix 3 (EP, page 9)</a>	[Calendar]
Initial interview	Open questions related to the use of the tool and decision-making processes.	See <a href="#">Appendix 4 (EP, page 10)</a>	[Initial_Interview]
Final interview	Open questions related to the use of the tool and decision-making processes.	See <a href="#">Appendix 5 (EP, page 11)</a>	[Final_Interview]
SUS	The System Usability Scale (SUS; Brooke, 1996) translated into Spanish and English (extracted from Gao et al., 2020) containing 10 closed Qs with 9 added inquiring if the information provided by the tool (indicators and graphs) is useful to support decision-making.	See <a href="#">Appendix 2 (EP, page 8)</a>	[SUS_WS] [SUS_Final_Interview] [SUS*] (for extra Qs added to the standard SUS Qs)

### 3.2. Sample

Three universities (one from Colombia [U1] and two from Guatemala [U2 and U3]) participated in this study. We chose convenience sampling to select the study participants based on our subjective judgment rather than random criteria. The universities participating in this study were selected among those directly involved in the PROF-XXI project. They all vary in terms of years of operation, size, and structure (public/private), representing different models of HEIs in Latin America. U1 is a public university committed to promoting innovation and entrepreneurship among its students and faculty. This commitment is demonstrated through various initiatives, including a business incubator, a technology transfer office, and a centre for entrepreneurship. U2 is a public institution that strives to provide students with a high-quality education that prepares them for the challenges of the 21st century while contributing to national development through innovation. At the same time, U3, a private university, has a forward-thinking approach to education and recognizes the importance of innovation in today's world. The institution emphasizes the development of an innovative culture through the promotion of collaboration and interdisciplinary research, ensuring that students acquire the necessary skills and knowledge to make meaningful contributions to the dynamic landscape of innovation. More information about the universities involved in the study is available in the supplementary material in [Appendix 1](#). All participants of this study had either administrative or expert roles at the selected universities and were involved in the decision-making process related to identifying, developing, and deploying competencies within their educational institution. They are all part of the PROF-XXI project and are already applying the PROF-XXI competency framework as a guideline for developing TLC activities in their HEIs.

Seventeen people participated in phase 1 (four from U1, four from U2, one from U3, and eight from other universities not selected for the study); in phase 2, thirteen people participated in the workshop (one from U1, two from U2, two from U3, and



eight from other universities not selected for the study); six people participated in the initial interview, (one from U1, three from U2, and two from U3); three people participated in the final interview (one from U1, one from U2, and one from U3); five people filled out the SUS questionnaire (two from U1, two from U2, and one from U3).

### 3.3. Analysis

Three researchers were involved in data gathering and analysis. First, we analyzed the decision-making processes within each institution before introducing the PROF-XXI tool [Interviews\_Decision-Making]. Second, we analyzed all the data collected [WS; Calendar; Initial\_Interview; Final\_Interview; SUS\_WS; SUS\_Final\_Interview; SUS\*] to extract partial results for each institution separately (see [Appendix 5](#), [Appendix 6](#), and [Appendix 7](#)). Third, we cross-analyzed the findings to obtain the final results.

All the interviews were transcribed and translated into English to ensure that all researchers were on the same page and could understand the information conveyed to them by the interviewees. In the first instance, all researchers analyzed the collected data independently to extract the partial results, keeping the RQs in mind. Then, the researchers discussed these individually extracted partial results to identify commonalities in the findings and co-produce their unified description. After that, each researcher cross-analyzed the partial results independently to extract the final results. And then, all researchers reviewed and revised these results to arrive at a consensus and generate a definitive list of final results.

## 4. Overview of the Initial Decision-Making Process

This section illustrates the decision-making processes adopted at the three universities included in this study (U1, U2, and U3) based on the data collected during the phase 1 interview. These findings serve as a starting point for evaluating whether institutional decision-making was transformed after introducing the PROF-XXI tool.

Table 3 summarizes the decision-making processes of the institutions' TLCs before introducing the PROF-XXI tool. As seen in Table 3, none of the three universities have either a specific document guiding the selection of required competencies nor established approaches regarding their evaluation and development. In U1 and U3, Rectors make the key decisions that are further implemented by Directors or Heads at the TLC level. Occasionally, the top management delegates the decision-making function to the institution's units or departments and authorizes them to decide on their own needs or a course of action to achieve short-term goals. Owing to U2's large size, each academic and administrative unit is autonomous and empowered to make its own decisions. All institutions employ post-event surveys to collect qualitative and quantitative data, focusing mainly on students, teachers, and their perceived abilities. However, these questionnaires are not insightful when defining the competencies required and making decisions regarding their development.

**Table 3.** Decision-Making Processes in Place at U1, U2, and U3 (gathered during the phase 1 interview [Interviews\_Decision-Making])

	University 1	University 2	University 3
<b>Pre-planning</b>	— No advanced planning to measure performance	— During the pandemic, a contingency plan was created	— In autumn 2021, a curriculum development plan was created to adapt courses to the digital context
<b>Decision makers</b>	— At the institutional level: top-level managers — At the level of TLC: middle managers	— Being a large HEI, every university unit is autonomous. — At the institutional level: top-level managers — At the level of TLC: middle managers	— At the institutional level: top-level managers — At the level of TLC: middle managers
<b>TLCs support actions</b> <i>Data collection, planning regarding teacher training and evaluations, verification of resources, proposals and pilot plans</i>	— Post-surveys are conducted to determine the level of student and teacher satisfaction with courses — Quantitative or qualitative online surveys through own system	— No formal mechanism for identifying student and teacher skills — Various post-surveys are conducted to determine the level of student and teacher satisfaction — Quantitative or qualitative online/offline surveys via own system	— Systematized evaluation practices are missing — Post-surveys are conducted to determine the level of student and teacher satisfaction — Qualitative group interviews with institutional curriculum experts for identifying improvements for digital learning
<b>Sources of data</b>	— Teacher training, reports, statistics, studies, surveys, tools logs, qualitative data — Collection of student and teacher perceptions of the courses. Objective tests are not applied.	— Teacher training, reports, statistics, surveys, and qualitative data — Collection of student and teacher perceptions of the courses. Objective tests are not applied.	— Follow-ups, reports, statistics, studies, qualitative and quantitative data — Collection of student and teacher perceptions of the courses. Objective tests are not applied.

## 5. The Cross-Analysis

This section presents the main findings of this study organized into two subsections. The first subsection gives an overview of the partial results for each case separately. The second provides the final results of the cross-analysis to answer the research questions.

### 5.1. Findings of the Separated Cases in the Multicase Study

Tables in Appendixes 5, 6, and 7 show the partial results for each university under analysis. [Table A5](#) summarizes the findings for U1, [Table A6](#) for U2, and [Table A7](#) for U3. All tables present the partial results for each research question and the selected data supporting each finding. The exhaustive supporting data sets for the three separate cases are available online in [Folder with Processed Data](#) and in [Appendix 4](#).

### 5.2. Results of the Cross-Analysis

The final results of cross-analyzing the findings of the three case studies are summarized in Table 4. For each research question, we present the main results and the findings for each case supporting them.

**Table 4.** Results of Cross-Analysis

Final results of cross-analysis	Supporting findings of separated cases
<b>RQ1: How is the PROF-XXI tool used in the institution, and for which purposes?</b>	
<b>R1.1</b> Universities use the tool on an ad hoc basis when a new initiative is launched by the TLC that needs to be evaluated.	<b>FU1-1.1</b> The tool is used on an ad hoc basis ( <a href="#">Table A5</a> ). <b>FU2-1.1</b> The tool is used on an ad hoc basis ( <a href="#">Table A6</a> ). <b>FU3-1.1</b> The tool is used on a weekly basis ( <a href="#">Table A7</a> ).
<b>R1.2</b> Since the tool has been recently introduced, it is mainly used to record the initiatives, diagnose them, and monitor participant answers regarding these initiatives.	<b>FU1-1.2</b> The tool is used for diagnosing teaching skills, tracking responses, and detecting other non-formal, randomly launched initiatives within the university, which also contribute to the development of skills ( <a href="#">Table A5</a> ). <b>FU2-1.2</b> The tool is mainly used to register and evaluate initiatives conducted by TLCs and collect the teacher and student perceptions about them ( <a href="#">Table A6</a> ). <b>FU3-1.2</b> The tool is used to register initiatives, compare the first and second questionnaire campaigns, review responses, and check the dashboards ( <a href="#">Table A7</a> ).
<b>R1.3</b> U1 unexpectedly discovered that the PROF-XXI tool helps detect initiatives other university units undertake that contribute to skills development but are not formally launched by the TLC.	<b>FU1-1.2</b> The tool is used for diagnosing teaching skills, tracking responses, and detecting other non-formal, randomly launched initiatives within the university, which also contribute to the development of skills ( <a href="#">Table A5</a> ).
<b>RQ2: How does the PROF-XXI tool support decision-making about the initiatives for the strategic development of TLC competencies?</b>	
<b>R2.1</b> Universities perceive the PROF-XXI tool as instrumental in supporting decision-making by providing key insights into the state of competencies, a signpost for areas of improvement and a possibility to monitor the progress with data.	<b>FU1-2.1</b> The tool is highly versatile and effective for diagnosing teaching skills and measuring the impact of initiatives ( <a href="#">Table A5</a> ). <b>FU1-2.3</b> The tool is perceived as useful for prioritizing initiatives and making decisions about teacher training ( <a href="#">Table A5</a> ). <b>FU2-2.1</b> The tool is instrumental for diagnosing the current state of competencies, tracking progress, and assessing the impact of initiatives ( <a href="#">Table A6</a> ). <b>FU2-2.2</b> The tool proves key in identifying areas of improvement, substantiating and implementing new initiatives, and is overall well suited for supporting decision-making ( <a href="#">Table A6</a> ). <b>FU3-2.1</b> The tool helps to identify areas of weakness, make decisions about new initiatives and improvements, and register the changes made ( <a href="#">Table A7</a> ).
<b>R2.2</b> Differences between universities are found in the amount of data collected. These differences are due mainly to the university's organizational structure. Universities U2 and U3 were able to collect a higher quantity of data because their unit of analysis (i.e., department) was bigger than in U1.	<b>FU1-2.2</b> The steady increase in data volume would make the tool fully supportive ( <a href="#">Table A5</a> ).

**RQ3: How have the decision-making processes been impacted/changed with the use of the PROF-XXI tool?**

**R3.1** Introducing the PROF-XXI tool as part of the DSS is perceived by decision makers as having a positive effect on decision-making by making it data-driven.

**FU1-3.2** Being underpinned by data rather than based on assumptions, the tool can show differences between university units or departments, which could potentially have a positive impact on the quality of the decision-making processes according to the decision makers (Table A5).

**FU2-3.1** The tool facilitates the decision-making processes by providing accurate and timely data, which makes the process, in general, more reliable and also adds a formal mechanism to collect information about the TLC’s competencies for innovation in teaching and learning (Table A6).

**FU3-3.1** The decision-making processes changed for the better since the tool provides an organized approach to identifying opportunities for improvement and is indispensable for general and preliminary mapping (Table A7).

**R3.2** The use of the tool complements the established data collection methods used at the institution, mainly informing about student and teacher satisfaction with courses.

**FU1-3.1** The tool enables the TLC to shift from expert-driven to data-informed decision-making. This means that they can make decisions about required training themselves and engage experts only when needed. This also adds a new dimension to what the institution was collecting before introducing the tool (Table A5).

**FU2-3.1** The tool facilitates the decision-making processes by providing accurate and timely data, which makes the process, in general, more reliable and also adds a formal mechanism to collect information about the TLC’s competencies for innovation in teaching and learning (Table A6).

**RQ4: How convenient are the PROF-XXI tool and the provided indicators in terms of usability?**

**R4.1** Decision-makers from the three universities perceive the tool as user-friendly, with effective data visualization and no remarkable technical issues. In particular, they value 24/7 access to the responses.

**FU1-4.1** The tool is user-friendly, and information visualizations are perceived as adequate to comprehend and interpret the data (Table A5).

**FU2-4.1** The tool is user-friendly, with round-the-clock access and no technical difficulties in sight. It was designed for TLCs specifically and, as a result, allows for systematized user experiences based on each competency dimension. It takes different stakeholder views into account and makes it possible to benchmark against other HEIs (Table A6).

**FU3-4.1** The tool has an intuitive design. Good visualizations are the tool’s upsides (Table A7).

**R4.2** Decision-makers highlight that there is some room for improvement in the tool design by making it responsive to different devices and modifying the questionnaire included by default to make it more understandable to their context.

**FU1-4.2** The tool is not mobile friendly, and the way “units” are classified creates difficulties when mailing to multiple recipients (Table A5).

**FU2-4.2** A slightly long questionnaire and perception-based responses may heighten the possibility of confusion in data interpretation, especially if some stakeholders are not aware of some aspects of other stakeholders’ work (Table A6).

**FU3-4.2** Confusing questions and a questionnaire covering areas some stakeholders may not be very knowledgeable about are considered the tool’s downsides (Table A7).

In our exploration of **RQ1**, which delves into the utilization of the PROF-XXI tool within educational institutions and its purposes, we uncovered several significant insights. The results show that **the universities adopted a flexible approach when it comes to deploying the PROF-XXI tool (R1.1)**. The tool was primarily used on an as-needed basis, often in alignment with the launch of new TLC initiatives that require evaluation. The research findings consistently support this dynamic pattern, with instances such as FU1-1.1, FU2-1.1, and FU3-1.1 underscoring its usage in conjunction with these TLC initiatives. For example, as reported by the Director of the TLC from U1, there is a daily check of the tool’s platform, especially during scan campaigns. The absence of a notification service means that they log in once a day to review responses. Interestingly, they also noticed a pattern where responses tend to decrease after the initial 24-hour period. As news or new data becomes scarce, the tool review frequency decreases to approximately once a week. A similar approach is observed at U2, though with a slightly lower frequency of the tool’s use. Meanwhile, U3 adopted a weekly schedule, with the tool’s role shifting toward the comparison of progress between the first and second scans. This is particularly practical feedback, offering insights into the platform’s regular usage. Furthermore, **the PROF-XXI tool functions as a versatile mechanism across all universities (R1.2)**. The research underscores the tool’s pivotal role in capturing valuable insights about competency development from stakeholders’ unique perspectives. This mechanism serves as a cornerstone of the tool’s functions. However, given the tool’s recent introduction, its primary functions include recording initiatives, diagnosing them, and closely monitoring participant responses concerning these initiatives. What is particularly intriguing is that **the PROF-XXI tool was used to identify novel**

**initiatives stemming from other institutional units (R1.3).** In U1, the tool was used to identify initiatives undertaken by other university units or departments, even when these initiatives significantly contribute to competency development, despite not being formally launched by or directly affiliated with the TLC. This expanded functionality was highlighted by the Director of the TLC from U1, who aptly noted: “Interestingly, [the tool] helped to identify initiatives not associated with the centre within the same university. For example, non-formal initiatives that are carried out and which contribute to the development of skills” (see FU1-1.2 in [Table A5](#)). In summary, the PROF-XXI tool proves itself as a versatile and adaptable asset within educational institutions. It is employed in response to specific needs, particularly when new TLC initiatives demand evaluation. Its crucial role in assessing competency development and monitoring initiatives is further enhanced by its unexpected capacity to detect unofficial initiatives contributing to skill development within the institution, which further underscores its significance.

Concerning **RQ2**, which revolves around the role of the PROF-XXI tool in supporting decision-making for the strategic development of TLC competencies, the first result, **R2.1, indicates that universities perceive the tool as eminently useful for diagnosing competency levels, identifying areas for improvement, and progress monitoring.** FU1-2.1, FU1-2.3, FU2-2.1, FU2-2.2, and FU3-2.1 support this result. Moreover, not only has the tool been specifically designed to facilitate the decision-making of TLCs, but it is also multifaceted and linked with the PROF-XXI competency framework and, thus, conducive to supporting the decision-making of TLCs. For example, the Director for the Centre of Teaching and Learning at U1 said: “The tool allows for modifying how it is used. [...] That sort of use is quite useful for decision-making processes” (see FU1-2.1 in [Table A5](#)). **R2.2 shows that using the PROF-XXI tool as a decision-making support correlates with the amount of data collected and the university structure.** For instance, while U2 and U3 managed to collect more information through the tool when launching a new initiative, U1 experienced some difficulties due to the smaller size of their units of analysis with a limited number of teachers and students to benefit from the tool fully (FU1-2.2). This implies that universities need to reflect on how to establish their units of analysis in the tool so as to collect the maximum amount of data. The **SUS\*** provides another interesting insight. Namely, U2 gave low scores to question Q18 (“I think that the tool helps to identify the strengths and weaknesses of the institution in terms of the level of skills”) with the average answer being 1.50 out of 4.00 (FU2-2.2), which is in sharp contrast to U3, which gave the maximum score to the same question, with an average answer of 4.00 out of 4.00 (FU3-2.1). It may be that U2 and U3 had different expectations of the tool and its capabilities, which could account for the difference in the scores. In summary, the PROF-XXI tool plays an important role in supporting decision-making processes within TLCs. Its effectiveness is acknowledged across institutions for competency diagnosis, performance assessment, and progress tracking. The fact that the tool is tailored to align with strategic TLC goals and is intricately connected with the PROF-XXI competency framework not only streamlines the decision-making process but also enhances it. Moreover, our research unveils the impact of data collection and institutional structure on the tool’s effectiveness, underscoring the need for universities to strategically configure their units of analysis within the tool. The divergence in SUS scores among institutions suggests that individual expectations and experiences also play a significant role in assessing the tool’s efficacy.

Regarding **RQ3**, which explores the transformational impact of the PROF-XXI tool on the decision-making processes of universities, our research revealed several noteworthy findings. **R3.1 indicates that the tool promotes data-driven decision-making by providing the right information in the right amount and, on the whole, has positively affected the universities’ decision-making.** The interesting point is that even though the institutions may not fully realize it, they have been re-engineering their decision-making processes since they started testing the tool, implying that with systematic use, the tool may become instrumental and even indispensable when making decisions. FU1-3.2, FU2-3.1, and FU3-3.1 reaffirm this result. For example, see the comment made by the TLC Director of U2 during the final interview provided in [Table A6](#). **R3.2 shows that the tool can be used as a complement to already-established institutional data collection methods in order to inform TLC competencies** (FU1-3.1, FU2-3.1). According to the **SUS\***, U1 and U3 perceive the indicators provided by the tool to be useful for decision-making by giving high scores to question Q19 (“I think that the indicators provided are useful to guide decision-making in the institution”) with the average answer being 3.00 out of 4.00 for U1 (FU1-3.2) and 4.00 out of 4.00 for U3 (FU3-3.1). To summarize, the PROF-XXI tool, in essence, is not just a tool; it is a catalyst for change, leading institutions toward a more data-centric approach to decision-making. The interviews conducted with the TLC directors echo this sentiment, encapsulating the tool’s capacity to drive systemic change. Additionally, the PROF-XXI tool seamlessly integrates with existing data collection methods, providing institutions with a holistic perspective on competency development. In turn, the SUS scores offer a glimpse of how different institutions perceive the tool’s contribution to decision-making, underscoring the profound influence of the PROF-XXI tool on reshaping and enhancing decision-making processes within the realm of TLCs.

Regarding **RQ4**, which delves into the convenience and usability of the PROF-XXI tool, **R4.1 indicates that universities find that the use of the tool is straightforward and simple;** the tool offers 24/7 access and practical and effective data visualization that conveys data findings in an impactful way; dashboards are well-designed, and data is displayed accurately and is not deceptive, ensuring reliability (see FU1-4.1 in [Table A5](#), FU2-4.1 in [Table A6](#), and FU3-4.1 in [Table A7](#)). As the

TLC Director of U1 pointed out, “The ease of use is significant” (FU1-4.1 in [Table A5](#)). In turn, the Director of the Centre for Teaching and Learning at U3 mentioned during the initial interview that “The dashboard is super” (FU3-4.1 in [Table A7](#)). **R4.2 suggests that the tool needs a smaller version of the web page to increase mobile user engagement.** Also, the generic nature of the questionnaire may lead to unintentional interpretation errors as it does not account for separate stakeholder groups when producing the answers to it (FU1-4.2, FU2-4.2, and FU3-4.2). According to the SUS\*, both U1 and U3 gave the maximum scores to question Q11 (“I think that the flow of steps [Creation of the unit of analysis, Creation of Scan, Monitoring] is easy to follow”) with the average answer being 4.00 out of 4.00 (FU1-4.1 and FU3-4.1). Also, both universities (U1 and U3) assigned high scores to question Q12 (“I think that the members of my institution could easily complete the form generating [Scan]”) with the average answer being 3.50 out of 4.00 (FU1-4.1 and FU3-4.1). These ratings imply that the tool is accessible, intuitive, and easy to use. In turn, U2 gave high scores to question Q14 (“I think that the indicators provided are enough to have an overview of the level of competence of my institution perceived by its main actors”) with the average answer being 3.00 out of 4.00 (FU2-4.1), meaning the PROF-XXI tool is well suited for TLCs by allowing them to quickly build data into dashboards and providing them with the right information in the right amount, making it easy for them to assess the current level of competencies and improve their decision-making. The SUS also reaffirms the positive results and showed a 29.11% increase in the scores between the first check at the workshop in September 2022 (average score 65.83 out of 100; N=6) and the second check at the final interview in January 2023 (average score 85.00 out of 100; N=6), indicating a yet more positive improvement in the usability of the tool after the participants had a chance to use it more extensively. The table in [Appendix 8](#) summarizes the results of the SUS, indicating the results obtained by each university separately during the workshop and final interview, along with the average scores and the percentage expression of increase. In summary, the research results affirm that the PROF-XXI tool is highly convenient and usable. It boasts an intuitive interface, practical data visualization, and effective dashboards, ensuring that users can readily access and interpret information for informed decision-making. While acknowledging the tool’s strengths, there is room for improvement in terms of mobile usability and tailoring the questionnaire to various stakeholder groups. Nonetheless, the overall usability of the tool is seen as highly beneficial to the institutions, supporting their data-driven decision-making processes.

## 6. Conclusion, Implications, Limitations, and Future Work

This study presents the results of analyzing the use of the PROF-XXI tool, an evidence-based DSS tool aimed at facilitating the decision-making of TLCs regarding teaching and learning innovation. By tracking the tool’s impact on decision-making across three cases, this paper articulates evidence that the PROF-XXI tool has a high potential to support or otherwise positively impact the operational and strategic decision-making of TLCs. This paper also confirms the tool’s relevance to the decision-making processes of TLCs by offering them a systematic way to evaluate an institution’s competency development, identify strengths and weaknesses, and spot opportunities for innovation. In addition, it is an easy-to-use and accessible tool that can be easily integrated into the institutional environment.

The results of this paper yield valuable insights and offer crucial practical and theoretical implications for various stakeholders, such as higher education leaders, university policymakers or researchers. In the educational context, this research paper addresses a notable gap within the literature by focusing on decision support systems tailored to fostering innovation in teaching and learning. While existing research has explored decision support systems for formal processes, the distinct needs and challenges of innovation in education have received less attention (Albon et al., 2016; Atkins et al., 2017). This study’s interviews with university managers further validate this gap. At the institutional level, our findings underscore the potential of DSS tools to enhance decision-making processes and, in turn, optimize the positive impact of innovation strategies of TLCs, aligning with existing literature (IPCC, 2014; Malkawi, 2018). This suggests that HEIs should establish clear strategies and frameworks for innovation in teaching and learning, with DSS tools serving as instrumental resources in this regard. The study also emphasizes the importance of continuous evaluation and adaptation of TLC decision-making processes, particularly in response to feedback and evolving circumstances. This adaptive approach is crucial for ensuring the relevance and effectiveness of decisions in achieving institutional goals. Furthermore, this research contributes to the field by bridging a gap in educational decision support systems and provides practical insights for HEIs seeking to enhance their innovation strategies. It highlights the need for a robust framework and underscores the value of ongoing evaluation and adaptability in decision-making, ultimately advancing the discipline of learning analytics by shedding light on qualitative, context-specific considerations in a predominantly quantitative and data-intensive field.

Our study shows that the PROF-XXI tool is well-accepted and well-appreciated for its user-friendliness, practical and effective visualizations, reliability and functionalities it offers. The research paper provides insights into how the tool facilitates the decision-making for teaching and learning innovation and can benefit those who aspire to develop tools of a similar nature.

The results and conclusions of this study should be interpreted within the following limitations, which should be considered in subsequent work. First, as the present research is based on a limited number of cases, interviews with a larger number of

comparable institutions are needed. In the future, we plan to conduct a new round of interviews to understand how the PROF-XXI tool can be incorporated into institutional ecosystems. Second, the limited number of responses received for the SUS questionnaire warrants a more robust quantitative analysis. Embracing both qualitative and quantitative lenses will allow us to delve deeper into the participants' contextual intricacies, perceptions, and experiences, thereby enriching the overall interpretative framework of the study and increasing the statistical reliability and robustness of the findings. Third, the limited duration of the study could have impacted the generalizability of the results, therefore necessitating the need for a study over a more extended period to examine more thoroughly the way the PROF-XXI tool supports decision-making for teaching and learning innovation and how it is integrated into the institutional environment.

Future work should include a long-term study with more institutions outside the PROF-XXI project. Understanding better how the tool impacts decision-making processes and how it is used and integrated into different institutional environments is essential. Such a study would provide an opportunity to assess the PROF-XXI tool's effectiveness in different settings and identify potential limitations or barriers to adoption. It would also allow for the collection of more diverse data, enabling a more comprehensive evaluation of the tool's benefits and drawbacks.

Additionally, a long-term study would enable the analysis of the PROF-XXI tool's impact over an extended period, which would provide valuable insights into its long-term sustainability and scalability. This information could be used to refine the PROF-XXI tool and improve its effectiveness over time.

To conduct such a study, a multidisciplinary team of researchers and experts would be required to design a robust methodology and select a diverse range of institutions to participate (Firth-Cozens, 2001). The study should be designed to collect both qualitative and quantitative data, including surveys, interviews, and observations, to provide a comprehensive understanding of the tool's usage and impact.

Whilst a long-term study with more institutions would be a valuable contribution to the field of decision-making support tools and would provide critical insights into how such tools can be effectively integrated into institutional environments to support decision-making, it is also crucial to recognize the potential for enhancing the PROF-XXI tool by incorporating other pertinent data sources considered by the institutions.

All data are in the public domain and are available online in [Folder with Supplementary Materials](#).

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The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. Ethical responsibilities of authors for this paper were obtained. All data is publicly available.

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