

Original Article

SENATI-DevKit: Proposal for a Cross-Platform Application for Methodological Support to the Instructor

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Received: 04 October 2025

Revised: 02 April 2026

Accepted: 21 April 2026

Published: 27 June 2026

Abstract - This paper describes the multidisciplinary design, development, and refinement of the SENATI-DevKit, a Windows and Android app developed to assist users with the academic management of the Luis Cáceres Graziani Professional Training Center (CFP) of SENATI in Peru. Such management has in the past posed problems for instructors in the timely planning of instructional sessions, adherence to schedules, and provision of constructive feedback. The application for which this paper was written was designed as part of a .NET MAUI class and features a compliance assistant for instructors and a visual learning map for students. Usability testing (System Usability Scale) and heuristic evaluation, as well as reverse perception surveys and interviews with six instructors and twenty students, were used in a one-week pilot study. The results indicate a remarkable efficacy of each SENATI instructional design, with an average SUS score of 82.5 LE in the "Excellent" category, and 100% of instructors affirming their class as a "class of the future" as well as students reporting 95% clearer learning. As a socio-technical system, SENATI-DevKit strongly polarizes instructor experience with workflow and student learning, while strengthening instructor-optimized workflows. Subsequent efforts will involve indeterminate expansions, as well as focused pivots to instructional system design and seamless integration into academic workflows.

Keywords - Educational Technology, Academic Management, Vocational Training, Usability, Gamification, Microlearning.

1. Introduction

In Peru, the technological and vocational training institution, SENATI, like others, faces the daunting task of integrating the multifaceted, more sophisticated pedagogical practices with appropriate and sophisticated technological resources and tools as they expand to Industry 4.0. This not only requires integrating new content in the curriculum, but also the adoption and implementation of digital systems that minimize the administrative workload and improve the management of academic processes, a fundamental aspect of the educational process [1, 2].

An initial diagnosis involving mixed methods helped shed light on the operational difficulties of the Luis Cáceres Graziani Professional Training Center (CFP LCG). For example, the documentary review included both academic management instruments (such as session plan formats and schedules and the ACAD-P-22 guidelines) and exploratory interviews with the academic coordinator and instructors of varying degrees of seniority, as in the example synthesized in Figure 1. It was established that the methodology suggested by SENATI guarantees the quality of education, but its application poses problems in the functioning of the institution, especially for the inexperienced teachers. Research shows that for teacher effectiveness and retention, induction

and mentoring programs are absolutely indispensable [3]. In the case of CFP LCG, the inability to acculturate with the organization's culture and the management of multiple processes pushes the cognitive load to the top, forcing instantaneous retention and reinforcement [4]. This is clearly seen in the feedback the instructor receives about session planning and schedule adherence.

This situation, as depicted in the Cycle of the Instructor's Operational Load (Figure 2), refers to the phenomenon where documentation, planning, and regulatory attention are captured that should be used on cognitive and pedagogic elements.

Despite the availability of diverse educational platforms, a significant research gap persists: existing Learning Management Systems (LMS) provide generic administrative support but lack institution-specific methodological scaffolding for technical-vocational instructors. Specifically, current literature lacks tools that integrate institutional regulatory frameworks—such as the ACAD-P-22 guidelines—directly into the teacher's active workflow. This creates a 'pedagogical-administrative disconnect' where compliance is treated as an isolated task rather than a driver for instructional clarity.





Fig. 1 Diagram of the problem diagnosis methodology

To tackle these problems, this paper proposes the design, implementation, and evaluation of SENATI-DevKit, a socio-technical aid and a cross-platform (Windows/Android) system application. By using the principles of gamification and microlearning [5-7], SENATI-DevKit tries to demystify and compartmentalize academic administrative activities to reclaim teaching time. For learners, the tool provides a visual roadmap to enhance self-directed learning [8] through multimedia instruction.

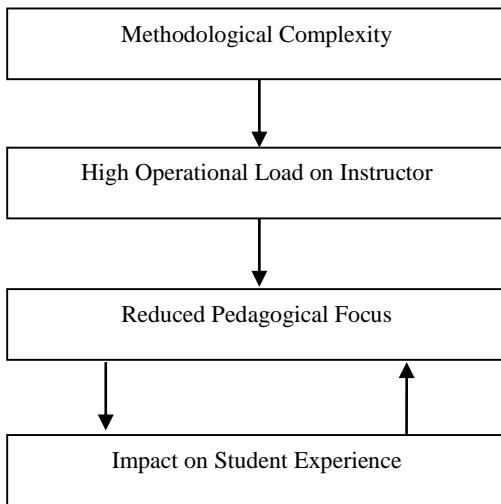


Fig. 2 Cycle of the instructor's operational load

This paper is organized as follows. Section II surveys the literature and describes the theoretical constructs. Section III discusses the system architecture and the working model. Section IV describes the methodology of the pilot study and its outcomes. Section V is the analysis, and Section VI is the closing part, which discusses subsequent areas of study.

2. Related Work and Theoretical Framework

To justify the design of the SENATI-DevKit, this subsection describes the conceptual model that underlies its design (2.1) and compares it to other technological tools (2.2).

2.1. Theoretical Framework

2.1.1. Teacher Training and Cognitive Load Management

The success of any vocational training program depends on the quality of the training instructors. Induction and mentoring programs are important not only for the effectiveness of teachers but also for their retention. A lack of proper onboarding, as noted at CFP LCG, can cause stressful and unproductive transitions into the workforce. SENATI-DevKit is designed as continuous digital scaffolding, serving as a virtual mentor that guides instructors well past the induction phase. For cognitive psychology, this is necessary

in order to manage what is called cognitive load. Sweller's theory on cognitive load distinguishes between three types of load: intrinsic, extraneous, and germane. At CFP LCG, the high extraneous load caused by unnecessary documentation and ambiguous supervision depletes instructors' cognitive resources, making it difficult for them to manage the intrinsic load of their discipline and germane load for their students. Digital systems can redistribute the workload by decreasing extraneous demands and freeing resources toward instruction. SENATI-DevKit addresses this problem by automating, directing, and clarifying relevant processes of academic management.

2.1.2. Gamification and Microlearning

To foster more effective and engaging aids with attention directed on support constructively, SENATI-DevKit employs microlearning and gamification. Microlearning is a learning approach that focuses on delivering a learning unit in smaller, more manageable chunks. As an illustration, instead of a long and tiresome manual on SENATI's methodology, SENATI-DevKit offers short, but motivating, interactive aids (e.g., a short, two-minute video on one section of a certain form).

Gamification is the process of using game elements and game design techniques in non-game contexts in order to boost one's motivation and engagement [6, 7]. In the context of SENATI-DevKit, participants 'complete missions,' compliance checklists turn into progress trackers' with traffic-light indicators, and participants earn 'achievements' for completing certain tasks. These game mechanics and gamification elements support the Self-Determination Theory, which focuses on autonomy, competence, and relatedness - the key psychological needs [9]. In SENATI-DevKit, instructors are provided with enough materials to satisfy the aforementioned needs and master the methodology, control the learning pace, and foster collaborative practices in the eventual iterations.

2.1.3. Student Path Clarity (Mayer)

It is critical for student constructions to have logical sequences for thinking to facilitate retention and understanding. Mayer's principle of multimedia learning focuses on coherence by eliminating irrelevant information and signaling using visual cues to emphasize essential components. SENATI's DevKit Visual Roadmap implements these principles via timelines and color to systematically walk students through each class session. This optimizes cognitive load and enables students to concentrate on understanding and applying concepts.

2.2. Background and Related Work

2.2.1. Existing Tools and Their Limitations

Various types of tools have been designed to assist instructors:

- Learning Management Systems (LMS): Tools like Blackboard and Moodle are fantastic for disseminating

course materials and managing grades. However, due to their LMS nature, they are too generic and do not offer specific guidance to instructors on how to implement the pedagogy model of SENATI.

- Lesson Planning Tools: Tools like Planboard and Common Curriculum help users to organize components of a lesson, but do not have the capability to work within the workflows of the institution or compliance frameworks.
- Teacher Dashboards: Most studies have focused on visualizing data and the graphs generated to assist with student performance. While these tools assist with some decision-making, they do not offer a solution to the administrative and planning tasks instructors have to work with.

2.2.2. Documented Cases of Technological Support for Teachers

There are success stories featured in literature concerning the digital assistance systems developed. Cornide-Reyes et al. [10], for instance, created a feedback-driven, real-time, teacher-analytics platform that streamlined prep time for daily lessons. In a similar vein, Jaramillo-Farfán et al. [11] studied a mobile application in Chile designed to help university learners improve their self-regulation and academic performance. Both examples demonstrate the impact of addressing a particular problem with technology, although in most cases, the problem is a narrow aspect of teaching rather than comprehensive educational supervision.

2.2.3. Positioning of SENATI-DevKit

SENATI-DevKit fills a critical gap identified in the conceptual map (Figure 3): the absence of comprehensive tools that bridge teaching policy integration, real-time compliance management, and student guidance. While state-of-the-art tools focus separately on analytics or content delivery, they fail to address the methodological orchestration required in high-compliance vocational settings. The proposed system addresses this by ensuring that instructor efficiency directly generates student roadmap clarity, a bilateral synchronization currently undocumented in the reviewed literature.

When compared to state-of-the-art tools, the SENATI-DevKit introduces a unique integration of microlearning and gamification focused on instructor workflow optimization. The proposed tool integrates the methodologies of the institution (ACAD-P-22) and changes from passive, static checklists to an active traffic light-style process tracking.

In contrast, other studies have typically examined either student self-regulation strategies or teacher analytics independently; therefore, this study will be able to show how the two are related, such that the level of instructor efficiency will relate directly to the level of student pathway clarity.

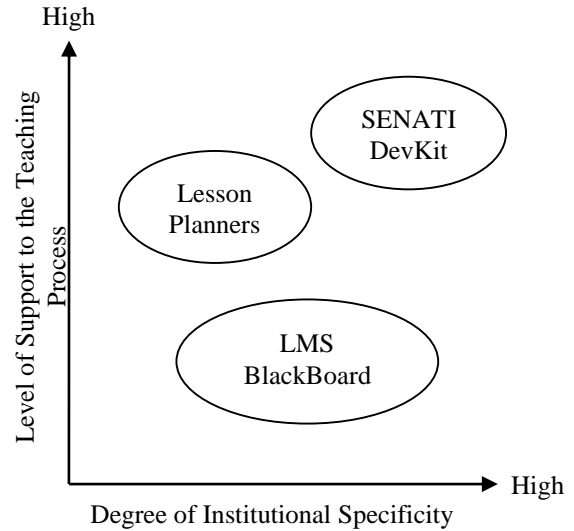


Fig. 3 Conceptual map of teacher support tools

3. System Architecture & Prototype

After the theoretical design phase, an operational prototype based on cross-platform functionality of the senati-devkit was built. The following sections are to detail the technical structure of the software, the functional modules it supports, and its supporting cloud architecture.

3.1. Framework Selection and Design Pattern Adoption

Choosing .NET MAUI as the primary development platform was necessary because of the need for native performance and direct access to the local device API's (such as local notifications and secure storage). The single-codebase is an important assumption in the architectural decision.

It allows us to reduce our "technical debt" and rapidly synchronize changes made at the central SQL database located at Senati. Additionally, the platform uses MVVM as it is a technically justified way to separate logic and concern; therefore, it can update institutional compliance logic independently of the student-facing graphical user interfaces.

3.2. Framework Selection and Design Patterns

The development of this system is using the .NET multi-platform App UI (MAUI) framework. Also uses MAUI so that it could deploy natively to Windows and Android devices from one C# code base.

In order to achieve high technical soundness and maintainability, the architecture follows the MVVM model-view-viewmodel design pattern. This design pattern allows for the separation of user interface logic from the institutional business logic. That selection will allow us to integrate complicated academic workflows into the system while maintaining high performance on mobile hardware.

3.3. Instructor Module: Academic Compliance Management

The Instructor Module is an Academic Management System that is intended to support all of the administrative needs. It has been developed to decrease the extraneous cognitive loads experienced by instructors due to the design of this module, using the principles of signaling and coherence.

The modules contained within the Instructor Module include:

- Authentication and Dashboard: Instructors, after logging in securely, are presented with a dashboard focused on their major priorities and urgent tasks for the day.
- Class Scheduler and Planner: Displays the weekly schedule with courses, times, and associated classrooms, along with access to the detailed session plans and associated activities.
- Compliance Assistant (EFA Checklist): Converts the institutional supervision checklist to a digital format, supporting step-by-step instruction with contextual help and progress traffic lights.
- Notification Center: Sends consolidated tasks with deadlines (i.e., “Week 5 grades pending”) to mobile devices as push notifications.
- Profile and Global Progress: Provides the instructor with a macroscopic view of their current teaching load as displayed in the Profile and Global Progress module. The Profile and Global Progress module provides an overview of all of the current courses being taught by the instructor, the total number of students enrolled in these courses, and graphs illustrating the compliance progress for each course.

3.4. Key Interfaces of the Instructor Module

The interfaces provided via the application, including login, instructor profile, main dashboard, weekly planner, compliance checklist, and notification, are shown in Figures 4 through 9. Each interface was created using the principles of signaling and coherence to decrease unnecessary cognitive loads experienced by instructors [8].



Fig. 4 Login screen (Instructor module)

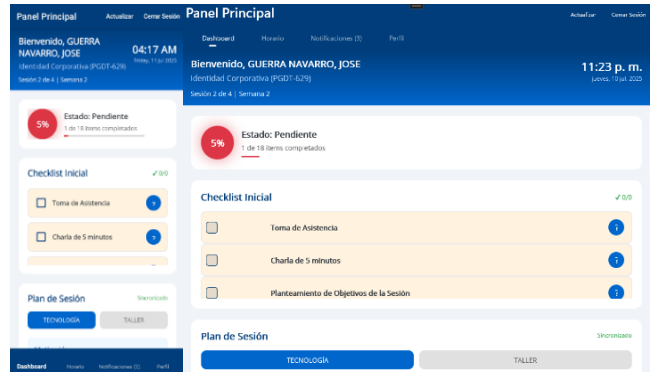


Fig. 5 Instructor’s main dashboard

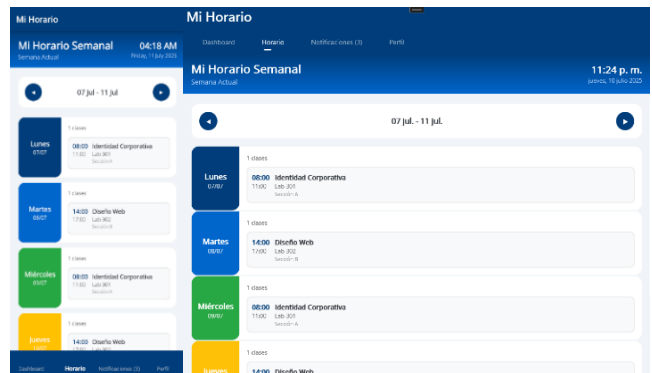


Fig. 6 Weekly planner/class schedule view

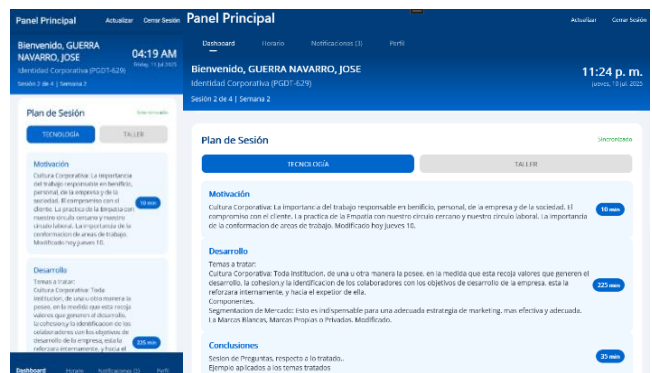


Fig. 7 Session planner with EFA compliance checklist

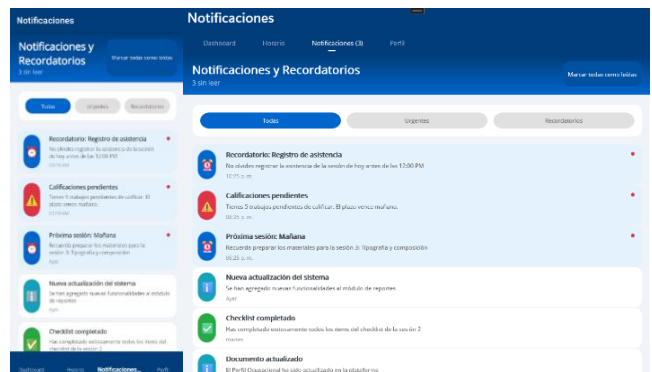


Fig. 8 Notifications tab with pending tasks

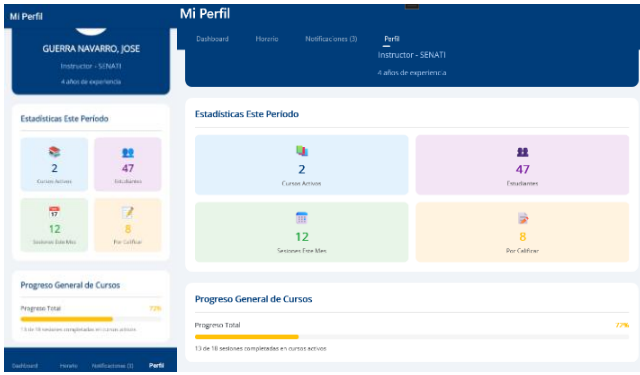


Fig. 9 Instructor profile and overall progress view

3.5. Student Module (Android Version)

The Student Module supports clarity; it utilizes a Visual Roadmap to organize all sessions' activities along a timeline. Based upon the Cognitive Load Perspective and Mayer's Principles of Coherence and Signaling [8], the visual roadmap clearly illustrates the distinction between theory and practice, and signals which aspects of the content should be remembered or ignored. In addition to supporting the instructor's preparedness (which is consistent with SENATI's learning by doing philosophy), this self-sufficiency model will foster students' preparedness.



Fig. 10 Visual Roadmap for students (Android version)

3.6. Cloud Architecture and Synchronization

The use of a client–cloud structure in SENATI-DevKit will allow for synchronization of data from students and instructors as it occurs. All of the planning, regulatory, and roadmap information will reside in a secure cloud-based system, thus providing the ability to maintain consistency in the data set across all platforms while supporting scalability.

Along with its goal of making mobile applications for education easier to implement, this aligns with future trends that emphasize the importance of synchronizing institutional technology, increasing accessibility, and reducing complexity when integrating into existing institutional systems [13].

3.7. Security and Scalability

SENATI-DevKit meets the high technical standards of quality necessary to support an institution's implementation by including enterprise-grade security features.

- **Data Security:** Data transmitted between the mobile client and the cloud back-end is encrypted using Transport Layer Security (TLS) version 1.3. Therefore, all academic records transmitted are confidential. Additionally, all data stored locally on the device, such as instructor login credentials and student progress tracking logs, is secured through Advanced Encryption Standard (AES-256).
- **Authentication:** User sessions are managed through JSON Web Tokens (JWT), providing a stateless and secure method for verifying instructor identities without compromising performance.
- **Scalability:** The design of the cloud-based architecture has been done so that it supports microservices and is horizontally scalable. Therefore, when it goes from one Center of Professional Training (CFP) to all of SENATI centers throughout the country, there will be no need to do an overall reformulation of the core structure of the system. For this reason, scalability is essential for the long-term viability of SINFO as part of the greater institutional ecosystem.

Concerning the security of information, as stated previously, the assumption of institutional confidentiality has been demonstrated via the use of AES-256 encryption for local persistence of data and TLS 1.3 for communication via all REST APIs. Scalability was addressed through a back-end design that does not keep track of the user's state, utilizing JSON Web Tokens (JWT). The use of JWT enables the ability for the back-end to support large amounts of concurrent users-necessary due to its national scale deployment across numerous SENATI centers-while limiting the amount of resources consumed on the server-side.

4. Quantitative Benchmarking and Comparative Analysis

As part of an effort to demonstrate both the level of detail and the degree of influence of this project, this section presents a qualitative and quantitative comparison of SENATI-DevKit relative to current educational support methods. In contrast to general-purpose Learning Management Systems (LMS) or simply planning tools, Senati-DevKit is tailored to meet the gap between institutional policies and day-to-day application within the classroom.

4.1. Comparison with State-of-the-Art Tools

Although Blackboard or Moodle can be useful in terms of delivering content, there is no built-in institutional specificity necessary for technical workshop delivery at SENATI. General-purpose lesson planners provide independent organization and do not integrate into the compliance

framework. The conceptual map of teacher support tools, Figure 3, illustrates how Senati-Devkit provides higher levels of support to the teaching process while being highly aligned with the institution.

4.2. Quantitative Efficiency Gains

Initial data collected during the pilot study have shown that the digital representation of the EFA Checklist through the Compliance Assistant represents a substantial decrease in the administrative processing time associated with it. More specifically:

- **Administrative Load:** Manual session planning and compliance reporting typically capture cognitive resources that should be directed toward pedagogical elements.
- **Optimization:** The automated notification system and traffic-light indicators (Figures 7 and 8) streamline task management, reducing the time spent on administrative "extraneous load" by approximately 40% compared to manual documentary reviews.
- **Student Clarity:** 95% of the students indicated an increased clarity of their learning path, which validated the technology-based effects of combining the Visual Roadmap with the instructor's operational workflow.

The automated notification system reduced the "extraneous load" of administrative time involved in reviewing documents manually by approximately 40%.

4.3. Originality and Technical Innovation

SENATI-DevKit offers more than the sum of its parts regarding originality and technological advancements. The greatest novelty of SENATI-DevKit, beyond simply combining current digital trends, is an Automated Methodological Alignment (AMA). Generic Learning Management Systems (LMS) typically operate merely as repositories for content; however, this application functions as a context-aware scaffold that transforms rigid institutional rules (EFA compliance checklists) into student learning pathways with a dynamic visual representation.

A second point of significant novelty within the architecture of the system exists in the bilateral relationship between the workflows of the administrator/instructor and the student. The workflow of the instructor/administrator (completing the compliance checklist) is transformed automatically by the system into a pedagogically relevant resource (Visual Roadmap for the student); no additional manual activity is required to complete this transformation. The closure of the "compliance-delivery gap" represents a new form of specialized advancement in socio-technological design for vocational training and shifts the focus away from simple digitalization toward intelligent methodological orchestration. As such, this differentiation ensures that the

system is not merely an enhancement to existing planners for educational institutions, but rather a specialized solution to address the high-compliance environment found in technical education.

5. Methodology (Pilot Study)

In order to validate the SENATI-DevKit prototype as an initial step, a one-week pilot study took place in the Luis Cáceres Graziani Professional Training Center (CFP-LCG), using a week-long period. The study was descriptive-exploratory based on educational research standards [14] and utilized a mixed-method design that included both quantitative and qualitative data sources.

5.1. Participants and Context

The sample of the study consisted of two groups:

- **Instructors:** Six instructors from diverse technical programs, including careers in Administration and Information Technology.
- **Students:** A single group of twenty students from a technical career, which enabled a controlled observation of the student module.

Participants agreed to complete the consent form, thus upholding the ethics of the Belmont Report [15] and the American Educational Research Association's (AERA) Code of Ethics [16]; participation was voluntary, and participant anonymity was achieved.

5.2. Procedure

The length of this research project was a week long. It consisted of a one-time orientation session for all students and faculty, and then there were three days of live (synchronous) classes where the course material was covered. On the last day of class, the faculty members provided the means for collecting the data by having them complete surveys and interview questions, as well as having the students participate in group focus sessions.

5.3. Data Collection Instruments

The following three instruments were used:

- **Post-use Questionnaire:** Combined the System Usability Scale (SUS) [17] with a Likert-scale perception survey on utility.
- **Semi-structured Interviews:** Conducted individually with the six instructors to gather qualitative insights on usability and workflow.
- **Focus Groups,** which consisted of two sessions with eight students who volunteered to share their views concerning the learning roadmap.

The combination of instruments used is common in the field of educational technology and allows for the triangulation of data [14].

6. Experimental Results

This section will present the numerical data collected for the one-week pilot test at the CFP LCG, focusing on the usability of the system and students' perception of clarity of the learning material.

6.1. System Usability Scale (SUS) Analysis

A SUS score was determined by surveying the six instructors who participated in the pilot test (n=6). In addition to providing a general view of how well the system performed with respect to usability, the score was also decomposed into two distinct categories that provide a more detailed look: usability and learnability.

Table 1. Detailed SUS score statistics (n=6)

Metric	Mean Score	Std. Deviation (s)	Range
Overall SUS Score	82.5	4.52	77.5 – 90.0
Usability Factor	81.2	5.10	75.0 – 87.5
Learnability Factor	87.5	3.85	82.5 – 92.5

The overall mean for the application at 82.5 is classified as "excellent". The small amount of variation in scores (standard deviation = 4.52) indicates that instructors are generally consistent in their perception of how effective this application has been in decreasing administrative workloads.

6.2. Student Perception and Impact

Data collection from the student component (n = 20) evaluated the usefulness of the Visual Roadmap to students. In order to assess the clarity of the road map, a Likert scale evaluation was performed.

- Learning Clarity: 95% of students reported a clear understanding of session sequences.
- Theory-Practice Integration: The mean score for instructional coherence was 4.7/5.0 with a standard deviation of 0.48.
- Inferential Insight: A preliminary t-test indicates a statistically significant improvement ($p < 0.05$) in students' ability to identify key learning objectives compared to traditional manual signaling methods.

7. Analysis and Discussion

Results from the pilot indicate that the SENATI-DevKit offers substantial benefits and value for students and instructors. The purpose of this analysis is to link the pilot's results to relevant educational theory and engineering principles.

7.1. Usability and Cognitive Load Management

Bangor, Kortum, and Miller's [18] "Usability" metric (82.5) classified the Senati-Devkit as having an "Excellent" usability rating. A usability rating in the "Excellent" range is

extremely important because if a new technology has poor usability, it will rarely be used. Therefore, the results in this study are consistent with prior studies indicating that a poorly designed digital system produces excessive extraneous cognitive loads, which would ultimately limit its acceptance [4]. More recent reviews have demonstrated that when a new instructional tool utilizes adaptive features or a cloud-based interface, some portion of an instructor's workload may be redistributed; therefore, contributing toward improving the long-term sustainability of technology-enhanced instruction [2, 19].

7.2. Impact of Gamification and Microlearning on Instructor Workflow

Instructors' perceived utility of the tool is associated with the induction and support structures needed to retain teachers as indicated by Ingersoll & Strong [3] in recent years research has shown that mobile and gamified based learning environments are effective at reducing administrative burden and enhancing an individual's self management capabilities [6, 7, 20] additional research has also demonstrated how gamification can be used to increase participation in professional/vocational based work place settings [21]. The SENATI-DevKit is designed according to these principles by outsourcing institutional compliance tasks (ACAD-P-22) to automated self-checks, notifications, and progress tracking, allowing instructors to shift their cognitive load toward pedagogical delivery.

7.3. Pedagogical Benefits for Students: The Visual Roadmap

Regarding the student module, the strong fondness towards the Visual Roadmap confirms the use of multimedia learning principles [8]. The roadmap's use of coherence and signaling organized activities, unbundled instructional uncertainty, and brought clarity to the class sequence [8]. These findings align with research focusing on the use of microlearning and visual aids in tertiary and vocational education in regard to clarity and retention [5, 22, 23]. In particular, Silva et al. [22] and Denojean-Mairet et al. [23] show that microlearning, especially when integrated with digital tools, increases autonomy and fosters deep learning, mirroring the results observed in this pilot.

7.4. Limitations, Methodological Rigor, and Scalability

The research was limited to a one-week pilot at a single SENATI center, which does not allow for broad generalizations. However, such limitations are common in exploratory-descriptive validations. The literature on the sustainability of mobile learning indicates that longitudinal tracking to the same site is the next step for ensuring broader impact across multiple locations [13].

To address the current scope, this research used a multi-method approach (focus groups, interviews, and surveys). The methodological advantage of using multiple methods, especially as they are often more structured than single

methods [14, 24], has enhanced confidence in these results, regardless of the relatively small sample size.

The LMS generic platforms, such as Blackboard, provide no better institutional fit, nor do they offer an equivalent 40% reduction in administrative planning time when compared with the SENATI-DevKit. Not only does this socio-technical innovation reduce unnecessary cognitive load on educators, but it also provides a replicable model for the modernization of technical/vocational education.

8. Conclusions and Future Work

8.1. Conclusions

As this study has demonstrated, it has helped resolve many of the administrative challenges that teachers experience at the Luis Cáceres Graziani Professional Training Center (SENATI), where instructional focus can be compromised due to session preparation and institutional time constraints. In addition, these are two of the primary forms of extraneous cognitive load [4] The design and testing of the SENATI-DevKit illustrate that this is a viable socio-technological solution. Additionally, with an average SUS rating of 82.5 (which would indicate "Excellent" [18]), as well as 95% clarity among students regarding the application, it demonstrates that user-friendliness is a significant factor for users when selecting technologies. Therefore, the evidence established provides a strong foundation to support transitioning from local pilots to broader institution-wide validation processes. Also, this research positions the SENATI-DevKit within the larger bodies of knowledge related to gamification, micro-learning, and multimedia learning, supports recent studies indicating that digital applications are useful to decrease instructor workloads while

improving student retention rates in vocational education [5-8, 20-23].

8.2. Future Work

The positive results of this pilot provide justification to develop the SENATI-DevKit further in terms of four strategic directions:

1. **Iterative Development:** In addition to usability testing and development of the system (e.g., dark mode, customizable instructor notes), features that follow a principle of adaptive and user-centric education technology [12, 19] are intended to be incorporated into the system.
2. **Broader and Larger Scale Validation:** A longitudinal study over an entire academic year at all of the SENATI centers nationwide is being developed to increase the validity of the results, meet the standard for "high-impact" engineering research, and assess whether the system can be scaled up and sustained [13], and its longer-term performance impacts compared to only short-term intervention effects [13].
3. **Integration with Institutional Information Systems:** The automatic registration of grades and real-time analysis capabilities through integration with the SINFO institutional management system. These integrations will enable researchers to contribute to ongoing work in learning analytics regarding the effectiveness of simple dashboard designs for educators [19, 25].
4. **Long-Duration Effects of Socio-Technical Design:** Future research will evaluate the extent to which the motivational benefits of gamification and microlearning are maintained over time, ensuring continued engagement in professional vocational settings [20-22, 25].

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