Integrating Experiential Learning, Distance Education, and Extension Curricularization in an Undergraduate Systems Analysis and Development Program

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ABSTRACT

Experiential learning is a well-established pedagogical approach that enhances student engagement and skill development through direct application. While widely adopted in in-person education, its integration into distance education remains underexplored, particularly in software engineering extension programs. This experience report investigates student perceptions of an experiential learning-based extension project within a distance education setting, specifically in a Systems Analysis and Development undergraduate program in Brazil. Using a mixed-methods approach, we analyzed student perceptions (from questionnaires and final reports) and the coordinating professor's reflective observations. Our findings reveal that experiential learning in distance education fosters both technical proficiency (e.g., software development practices and agile methodologies) and professional identity formation (e.g., teamwork, communication, and project management skills). However, challenges such as balancing autonomy and guidance, remote collaboration barriers, and time management struggles emerged as obstacles. Our study contributes by offering actionable lessons for integrating experiential learning into software engineering distance education through the curricularization of extension.

KEYWORDS

Experiential Learning, Distance Education, Curricularization of Extension.

1 Introduction

Distance education has emerged as a pillar of higher education in Brazil, expanding learning opportunities for diverse populations, including those in remote and underserved regions [5]. Between 2011 and 2021, the number of students enrolled in higher education courses, in the distance learning modality, increased by 474% [23]. This expansion has been driven by government initiatives (e.g., *Universidade Aberta do Brasil*) and technological advancements, enabling institutions to offer a wide range of programs in a flexible and scalable manner [11, 19]. In Brazil, the undergraduate program in Systems Analysis and Development (SA&D) is a technological higher education course recognized by the Brazilian Ministry of Education (MEC), covered by the Training References for Undergraduate Courses in Computing from Brazilian Computer Society (SBC), and widely offered through distance education. With a minimum workload of 2,000 hours, the SA&D curriculum equips students with the skills to analyze, design, develop, test, and maintain software systems, addressing the growing demand for qualified professionals in the technology industry.

Recently, one of the key guidelines established by the MEC for higher education courses has been the curricularization of extension activities [25]. This policy requires the formal integration of extension projects into academic programs, requiring that at least 10% of the total course workload be dedicated to activities that promote engagement with society through extension initiatives. Hence, the primary goal of extension activities is to enable student education by facilitating real-world interaction and contributing to social transformation [55]. While integrating extension activities into in-person undergraduate programs is already not trivial [26, 49], the challenge is even greater in the context of distance education, where logistical and interactional barriers can limit student participation [54, 56]. Just like in in-person settings, creating meaningful learning environments that allow the practical application of knowledge is a pressing concern in distance education, but with its own challenges (e.g., limited interaction, technological barriers, difficulties in assessing practical skills remotely, and the need for greater self-discipline from students).

The application of knowledge in real-world contexts is closely aligned with the principles of Experiential Learning Theory (ELT), which emphasizes learning through experience [43]. More specifically, Kolb [37] defines this process as "the way in which knowledge is created through the transformation of experience" highlighting the importance of active engagement in learning. This model has been widely recognized for its effectiveness in fostering professional and personal development, especially in fields that require hands-on problem-solving and adaptability such as SE [20].

Despite its potential, the integration of experiential learning into distance education through extension projects remains considerably underexplored in SE education. While the curricularization of extension in in-person settings has been increasingly discussed by SE scholars in Brazil [15, 58], its implementation in distance education programs remains largely unknown. On the other hand, while the potential of experiential learning has been successfully explored in SE education [30, 53], studies on its adoption in extension activities within SE distance education also remain scarce. Addressing these gaps can provide findings into how experiential learning and extension projects can enhance student engagement, skill development, and societal impact in distance education for SE.

This paper has the objective of discussing an experience report on the implementation of an experiential learning-based extension project in the SA&D distance education program at the Federal University of Cariri (UFCA). The project, carried out between March and December 2024, aimed to create an educational and interdisciplinary space for scientific dissemination on the social, human, and economic aspects of software. Conducted in collaboration with the Workshop on Social, Human, and Economic Aspects of Software (WASHES), the project provided students with hands-on experience in developing two major software artifacts: an institutional website[1] for WASHES and the implementation of dataWASHES[2], a public, academic, and open-source Application Programming Interface (API) designed to streamline programmatic access to data from WASHES proceedings [2]. By engaging in the engineering of these artifacts, students immersed themselves in experiential learning within a distance education context. This experience offered opportunities for the students to develop technical artifacts that contributed to scientific dissemination and open science, bridging the gap between skill development through experiential learning, curricularization of extension, and distance education.

Through this experience report, we contribute to SE education by providing empirical evidence on the experience of integrating experiential learning into distance education through extension activities. Our findings offer lessons learned for educators and institutions, highlighting strategies to enhance student engagement and foster practical skill development. Moreover, this study contributes to ongoing discussions on best practices for curricularizing extension in distance education, including within technology-focused programs such as SA&D.

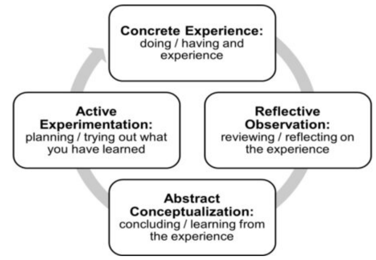
The remainder of this paper is structured as follows: Section 2 presents the background and related work on experiential learning, distance education, and the curricularization of extension. Section 3 outlines the research design, including the context of the experience and the characterization of the participants. Section 4 details our findings and lessons learned. Section 5 clarifies the key takeaways, future directions and limitations of this study. Section 6 concludes the paper with final remarks.

2 Background and Related Work

2.1 Experiential Learning

Experiential Learning (EL) is a pedagogical approach that prioritizes learning through direct experience, actively engaging students in problem-solving and critical reflection [36]. Rooted in Kolb's Experiential Learning Theory [37], this approach posits that effective learning occurs through a cyclical process of four interdependent phases (see Figure 1): *concrete experience*, where learners actively engage in new experiences; *reflective observation*, where they critically analyze their experiences; *abstract conceptualization*, where they integrate their observations with existing knowledge frameworks; and *active experimentation*, where they apply new insights to real-world situations. This iterative process fosters deep learning by bridging the gap between theory and practice.

Figure 1: The experiential learning process's four phases



Unlike traditional approaches, EL immerses students in authentic and hands-on experiences, allowing them to engage with technical concepts while developing soft skills [29]. For this reason, EL has gained traction in SE education over the years as an approach to bridge the gap between theoretical knowledge and real-world application [34]. For example, Krusche et al. [38] examined game development courses that incorporate EL principles, demonstrating that students developed technical skills, the ability to iterate quickly, and worked effectively in teams. In requirements engineering education, Regev et al. [53] designed EL-based activities that placed students in realistic stakeholder interactions, improving their ability to gather and refine software requirements. Lieh and Irawan [40] took a similar approach in software architecture courses, demonstrating that students who engage in hands-on design exercises gain a more sophisticated understanding in design trade-offs, architectural decision-making, and system-level thinking

Active learning strategies, such as problem-based and project-based learning, also align closely with EL principles. These strategies encourage students to take ownership of their learning by working on real-world problems [1, 32]. Lowe et al. [41] investigated structured EL strategies, such as case studies, peer reviews, and software walkthroughs, highlighting their effectiveness in reinforcing SE concepts in practice. Che et al. [12] further validated EL's benefits by applying confirmatory factor analysis, showing a direct correlation between experiential activities and improved student motivation, engagement, and perceived learning quality.

Hackathons provide another compelling example of EL in action [59]. These fast-paced events immerse students in collaborative problem-solving under tight deadlines. Araújo et al. [3] observed that hackathon experience promoted innovative and creative thinking, collaboration and teamwork, and knowledge application among students. In addition, agile methodologies have also been leveraged as EL approaches in SE education, providing students with iterative and feedback-driven learning experiences. In this regard, Coupal and Boechler [16] investigated student-led agile projects, finding that the iterative nature of agile development fosters deeper engagement with software processes. Christov and Hoffman [14] introduced mentorship structures in SE courses, where senior students guided junior teams, simulating real-world software development environments. Similarly, capstone projects that incorporate agile workflows, as studied by Datta [20] and Fagerholm and Vihavainen [29], prepare students for the collaborative and evolving nature of professional software development. In this regard, an illustrative example of EL in SE education is the Undergraduate Capstone Open

[1]https://washescommunity.github.io
[2]https://washescommunity.github.io/datawashes

Source Projects program, which enables students to contribute to open-source projects under industry mentorship [34].

In summary, EL has proven to be a promising approach in SE education, enriching students' understanding of agile development, software architecture, requirements engineering, software development, and capstone projects. However, while its benefits are well-documented in in-person settings, EL's adoption in distance education remains largely under explored. Understanding how students engage with and perceive EL within distance education is relevant for refining pedagogical strategies and ensuring meaningful learning experiences in SE programs.

2.2 Distance Education

E-learning, online education, distance education, and virtual education have gained prominence in recent years; however, it is important to first understand the nuances that distinguish them. E-learning broadly refers to the use of electronic technologies to deliver educational content and support learning [17]. In turn, online education is a subset of e-learning that specifically relies on the internet to provide courses, programs, and certifications. Distance education, in contrast, is a broader concept that encompasses various instructional methods for delivering education to students who are physically separated from instructors [44]. While e-learning is always digital, distance education can include both digital and non-digital approaches to overcome geographical and time constraints [33]. Meanwhile, virtual education takes this a step further by creating digital environments that simulate physical presence, such as virtual classrooms or immersive simulations, allowing students to practice and apply their knowledge in interactive ways [39]. In particular, the COVID-19 pandemic accelerated the adoption of online education, but this shift was often abrupt, with many institutions transitioning to remote teaching without the infrastructure or preparation typically associated with distance education [47, 51].

The importance of distance education in higher education in Brazil has grown substantially, particularly in the context of expanding access to quality education in remote areas [45]. With a large portion of the population residing in distant or underserved regions, distance education provides a solution to the issue of access, allowing students to pursue higher education without having to relocate or commute long distances [7]. Therefore, distance education has evolved into a powerful and transformative model, enabling students to access learning opportunities from virtually anywhere. In this regard, the number of students enrolled in distance education courses in Brazil has considerably increased. In 2021, students entering distance education courses accounted for 62.8% of all entrants, up from 18.4% in 2011 [61]. Specifically, private institutions dominate the distance education sector in Brazil, offering the majority of vacancies and enrolling a larger proportion of students compared to public institutions [60].

As highlighted in the "Cadastro Nacional de Cursos e Instituições de Educação Superior"[3], the Systems Analysis and Development (SA&D) undergraduate program is one of the most widely disseminated technological courses in Brazilian distance education. This program is offered by numerous institutions across the country and serves as a gateway for many students into the technological field of software development. With a minimum workload of 2,000 hours, the SA&D curriculum equips students with the necessary skills to analyze, design, develop, test, and maintain software systems, addressing the growing demand for qualified professionals in the technology sector [18]. In comparison, the minimum workload for bachelor's degrees in Software Engineering in Brazil, as per CNE/CES Resolution No. 2/2007, is 3,000 hours [46].

However, integrating distance education into SA&D and SE programs presents several challenges [21, 52]. These issues include ensuring student engagement and motivation, maintaining high-quality interactions with instructors, and providing sufficient practical learning opportunities. Moreover, the absence of face-to-face interaction can lead to feelings of isolation among students, potentially impeding the development of collaborative skills, which are critical in the software industry [31].

2.3 Curricularization of Extension

Extension in Brazilian higher education constitutes activities that bridge universities with the broader community [24]. These initiatives strategically disseminate academic knowledge and expertise to address social, cultural, and economic challenges. Unlike traditional classroom instruction, extension projects emphasize real-world problem solving, community engagement, and knowledge democratization [50]. They function as a link between academic learning and societal needs, creating reciprocal benefits for both students and the communities they serve [10].

The curricularization of extension refers to the systematic integration of extension activities into the formal academic curriculum [25]. Rather than remaining optional or extracurricular, community engagement projects become a structured component of a student's educational journey [55]. In SE programs, curricularization of extension has the capability of connecting classroom learning to real-world problems, offering students a chance to work on meaningful software projects that have a tangible impact on society. These initiatives often involve partnerships with external stakeholders, where students can tackle real challenges and develop solutions that matter beyond the university.

Building on these concepts, recent research demonstrates the practical implementation of curricularized extension in SE education. Matos et al. [42] found that problem-based extension activities embedded within the curriculum enhanced students' project management, software development, and communication skills. Their findings revealed these experiences fostered independence and professional confidence, empowering students in both their technical and civic roles. In turn, Barcellos et al. [6] described how the "Ricardo de Almeida Falbo" Software Engineering Practices Laboratory at Federal University of Espirito Santo bridged the gap between theory and practice, allowing students to work on projects that applied software engineering methods to meet real societal needs.

Further illustrating this expansion of extension activities, de Paiva et al. [27] documented how extension projects employing agile methodologies helped micro and small businesses improve sustainability outcomes. Through these initiatives, students strengthened their technical competencies and developed adaptability when confronting the unpredictable nature of real-world business environments. Similarly, de Andrade et al. [22] examined the integration of

[3]https://siead.mec.gov.br

software factories in SA&D in-person program, where students engaged with projects mirroring industry demands, thereby strengthening the alignment between academic preparation and professional practice. Bringing another perspective, Bordin [9] demonstrated how collaborative industry partnerships incorporating agile project management methodologies helped students cultivate soft skills, including teamwork, time management, and client communication. In a more recent study, Tives et al. [58] highlighted how extension projects aligned with Sustainable Development Goals encouraged students to leverage their technical expertise for societal benefit, engaging with community-driven solutions.

This diverse array of examples illustrates how curricularized extension in SE transcends traditional pedagogical approaches by immersing students in challenges that require practical application of their knowledge. This integration encourages the development of graduates who are both technically proficient and socially responsible. However, despite these documented advantages in in-person educational settings, there remains limited empirical understanding of how such curricularized extension projects impact students in distance learning environments. Investigating student perceptions of their engagement with these initiatives could provide findings to enhance and refine extension-based educational strategies in online or hybrid modalities, for example.

2.4 Research Gap

While experiential learning has been extensively explored in traditional classroom settings, a gap exists in research on integrating these approaches within distance education for SE with extension projects in Brazil. Existing studies [6, 9, 22, 42] typically emphasize in-person approaches, overlooking the challenges and opportunities posed by distance education. Moreover, the curricular integration of extension activities within SE education remains in the early stages. In summary, this study seeks to address these gaps by investigating student perceptions of an experiential learning-based extension project in a distance education setting, contributing to enhancing our understanding of effective pedagogical strategies for distance education and extension-focused SE education.

3 Experience Report

3.1 Design and Context of the Experience

This experience report examines an experiential learning initiative within the System Analysis and Development (SA&D) distance education program at the Federal University of Cariri (UFCA) between March and December 2024. The project addressed two challenges in Software Engineering education: providing software development experiences for distance learners and integrating extension activities with experiential learning. The initiative established a collaboration with the Workshop on Social, Human, and Economic Aspects of Software (WASHES). In summary, WASHES provides an academic platform for the community to discuss the social, human, and economic aspects of software and their associated challenges, which influence its development and use.

More specifically, students engaged in developing two software artifacts with practical applications in terms of Open Science: an institutional website for WASHES and dataWASHES. The development of these artifacts was motivated by the role of the WASHES in the Brazilian software engineering research landscape. With its upcoming 10th edition in 2025 and a substantial archive of published papers spanning diverse topics and authored by researchers from various backgrounds and regions across Brazil, WASHES represented an ideal candidate for improved digital infrastructure and scientific dissemination. Hence, the institutional website was conceived to enhance visibility and accessibility of workshop content, providing a dedicated platform to showcase WASHES's focus. Meanwhile, dataWASHES was designed as a open science resource offering programmatic access to the workshop's proceedings through a programmatic API. While WASHES proceedings were already openly available through SBC OpenLib (SOL), access was limited to manual retrieval, creating inefficiencies particularly for researchers conducting secondary studies or comprehensive analyses of the workshop's contributions over time. This scenario created a valuable context for experiential learning, where students could simultaneously develop technical skills and engage in extension activities through open science and scientific dissemination practices.

The project management structure was grounded in Kolb's Experiential Learning Cycle, emphasizing continuous iteration, reflection, and feedback. To this end, we incorporated adapted Scrum practices: students were divided into two teams (one for website development and another for dataWASHES implementation) working in two-week sprints. Bi-weekly synchronous meetings were held to review progress and plan upcoming cycles. Each sprint featured a rotating communication facilitator role, fostering leadership and coordination skills across the cohort. Rather than appointing a fixed Scrum Master, facilitation responsibilities were distributed to promote broader student ownership and communication. The coordinating professor assumed a hybrid project manager/product owner role, ensuring alignment with learning goals and stakeholder expectations. Complementing these practices, each student maintained weekly activity logs in a shared spreadsheet and submitted a final reflective report. Together, these mechanisms supported structured experiential learning by embedding regular feedback loops and reflective practice into the project workflow.

The eight-month engagement allowed participants to experience multiple iterations of planning, development, review, and reflection, aligning with both software engineering practice and Kolb's experiential learning cycle [37]. This sustained duration was important in the distance education context, where building collaborative momentum can be challenging. The project thus exemplified a valuable model for extension in distance education.

3.2 Data Collection and Data Analysis

Our methodological protocol incorporated both an anonymous questionnaire and reflective analysis. The questionnaire provided structured feedback from students served as a primary instrument for data collection, while reflective analysis by the coordinating professor (first author of this study) further enriched this data by capturing personal insights gained from the experience.

The questionnaire was administered in late November 2024, strategically timed to capture participant experiences near project completion while ensuring sufficient responses before the academic term ended. A prior pilot test with one participant led to minor wording adjustments for clarity, such as adding "approximately" to the question on enrollment duration. The questionnaire opened with a Term of Free and Informed Consent explaining data usage, confidentiality measures, and participant rights, followed by demographic questions gathering contextual information while maintaining anonymity. The core sections were structured around Kolb's Experiential Learning Cycle, with specific questions examining each dimension: concrete experience (e.g., "I felt that the experience in the project was relevant to my professional development"), reflective observation (e.g., "During the project, I had moments when I stopped to reflect on the decisions made and actions taken"), abstract conceptualization (e.g., "I was able to apply theories and concepts learned in course subjects during project development"), and active experimentation (e.g., "I felt challenged to put solutions to real problems into practice during the extension project"). Additional questions explored participants' prior experience with extension projects and collaborative software development, duration of enrollment at UFCA, perceived professional development, squad assignment, and project completion status. Open-ended questions solicited detailed reflections on lessons learned and potential future applications of acquired knowledge, generating qualitative data complementing the quantitative measures.

Complementing this self-reported data from students, the coordinating professor conducted a reflective analysis throughout the project lifecycle, consistent with reflective practice methodology in educational research [28]. This approach also leveraged multiple documented sources including the weekly activity logs maintained by students in a shared spreadsheet, final reports submitted at project completion, GitHub contributions, etc. The reflective analysis focused on identifying patterns in student engagement, technical challenges encountered, collaborative problem-solving approaches, and the evolution of project dynamics over time. This methodological approach provided valuable instructor perspectives while acknowledging the inherent interpretive nature of reflective analysis. By incorporating project documentation, this approach strengthened the credibility of the instructor insights and increased methodological transparency about the interpretive process.

Therefore, our analytical approach integrated these complementary data sources through mixed methods. Quantitative analysis employed descriptive statistics to examine response patterns across Likert-scale items measuring each dimension of Kolb's cycle. For qualitative data, we conducted open coding of questionnaire responses, student reports, and activity logs. This process yielded a hierarchical coding scheme capturing both anticipated themes aligned with experiential learning theory and emergent patterns specific to the distance education context. Through subsequent axial coding, we established relationships between these concepts. For example, the open code "technical skill development", which emerged in comments describing the acquisition or improvement of specific technical competencies, was later grouped axially under the broader category "Technical / Personal Growth". Moreover, the integration of student perspectives with project artifacts enabled methodological triangulation, strengthening the validity of our findings. Lastly, all instruments, primary data, and the qualitative codebook used in this study are available in our supporting repository for this paper [4].

3.3 Characterization of the Students

The initial cohort for this extension project comprised 30 students from the SA&D distance education program at UFCA. During the early stages of the project, 7 students disengaged due to factors such as time constraints, competing academic commitments, and course withdrawal. An additional 4 students later withdrew after limited involvement, resulting in 23 students who demonstrated at least a moderate level of active participation. To ensure meaningful assessment, we targeted this group of 23 students. However, one was excluded from the questionnaire distribution due to their participation in the pilot test, leaving 22 students who received the final version of the questionnaire. We received 21 completed responses, including the one from the pilot participant, resulting in a 91.3% response rate among the actively engaged participants

The participants ranged in age from 20 to 36 years old, with a mean age of 27.25 years (SD = 5.24). The majority of participants (65%) were between 20 and 29 years old, while 35% were 30 years or older. This age distribution reflects a diverse group of students, including both traditional college-age students and mature learners. Regarding their academic experience, participants reported being enrolled in the UFCA for varying periods, ranging from 4 to 30 months, with a median enrollment time of 21 months. This issue indicates that most participants were in the middle stages of their academic journey when they joined the extension project. The dataWASHES squad comprised 55% of the survey respondents (11 students, including those handling API-related documentation), while the Website squad accounted for 45% (9 respondents).

The longitudinal commitment to the project varied among participants, with 70% (14 participants) remaining until the project's conclusion in December 2024, while 30% (6 participants) withdrew during the development process. For those who left the project before completion, the reported reasons revealed typical challenges faced by distance education students: academic commitments and increased workload in other courses (2 participants), personal issues including health concerns (2 participants), work-related constraints (1 participant), and academic withdrawal from the course (1 participant). These attrition patterns align with known challenges in distance education contexts, where students must balance academic pursuits with professional and personal responsibilities.

The answers also revealed important information about participants' prior experience. Notably, 85% (17 participants) had no previous experience with extension projects, emphasizing the project's role in introducing students to extension activities within the university context. Regarding software development experience, 40% (8 participants) reported that this was their first experience in a software development project, indicating that the extension project served as a critical entry point to collaborative software development practices for a considerable portion of participants. The remaining participants brought varying levels of prior experience: 35% (7 participants) had prior experience with both academic and personal software projects, 20% (4 participants) had experience only with academic software projects, and 5% (1 participant) had experience only with personal software projects. This distribution of profiles created a environment for knowledge exchange and peer learning, where more experienced students could naturally mentor those with less experience.

3.4 Findings

3.4.1 Overall Perception of the Students. This analysis focused on three questions: a quantitative assessment of whether participation contributed to a greater understanding of their professional role (measured on a 5-point Likert scale), followed by two open-ended qualitative questions exploring the lessons learned for their professional development and how they intended to apply this learning in future professional contexts. When asked whether their participation contributed to a greater **understanding of their professional role**, an overwhelming majority of participants responded positively. On a 5-point Likert scale, 85% of respondents selected the highest rating (5), indicating strong agreement, while the remaining 15% selected a rating of 4 or 3. This nearly unanimous positive response suggests that the experiential learning approach contextualized theoretical knowledge within practical applications, helping students visualize their future professional identities.

When asked about **essential lessons learned for their professional development**, participants' responses coalesced around two codes: technical skill development and the value of collaboration and teamwork. In terms of technical skill development, students highlighted the practical experience in software engineering practices as quite valuable. One participant (P15) noted: "*One of the main highlights was the practical experience in technical development, where I was able to not only develop and improve my hard skills, but also gain confidence in what I am capable of achieving*", highlighting the value of experiencing extension work in a distance education modality. P7 emphasized: "*I learned valuable lessons that I consider essential for my professional development. I further developed my ability to work in a team, improving both my hard and soft skills, such as communication, collaboration and problem-solving*". The value of collaboration, teamwork, and management practices also emerged as a relevant code across responses. For example, P1 reflected: "*Collaboration, participation, and teamwork. Always respecting and learning to listen and share ideas with your team for improvement and to contribute to everyone's participation*". This focus on interpersonal dynamics suggests that the project successfully facilitated the development of soft skills that are highly valued in professional software development environments but often difficult to cultivate in traditional distance education contexts. P8 articulated learning about "*Work divided into sprints, working in groups, estimating time for activities, improving communication, organization, improving the hard skills required for website development...*". These reflections demonstrate how the project provided exposure to professional practices beyond coding, encompassing the software development lifecycle and management processes.

When questioned about their **intention to apply their learning in future professional contexts**, participants indicated plans to transfer their knowledge to workplace settings, leading to the emergence of the code transferability of technical practices. P15 clarified: "*I'm already applying it! The use of the Scrum framework taught me to structure tasks, prioritize demands and work in short cycles with iterative deliveries. In my current internship, I am applying this exact approach to keep my processes more organized and efficient*". P2 highlighted the transferability of specific technical practices: "*The project also helped me to immerse myself in the professional environment, I used GitHub at various levels, in addition to just delivering commits, I also used actions*". This reflection demonstrates how concrete technical experiences were abstracted into generalizable principles that could be applied across different contexts.

The responses also revealed how the project allowed students to clarify their professional identity formation. P11 noted: "*I had a very narrow view of what it was like to develop software... But in the extension project I learned to solve problems more efficiently (and in groups)...*". This sentiment was echoed by others who described how the project helped them determine which areas of software development aligned with their interests and strengths. Participants also characterized their learning not merely as acquiring discrete skills but as adopting a professional mindset. P16 observed: "*I learned the importance of communication to keep the team aligned, the value of teamwork in bringing together ideas and skills, and I took advantage of the opportunity to apply knowledge, overcome challenges and grow professionally*". This issue suggests that the experiential learning approach facilitated not just technical skill development but also professional socialization, the internalization of the values, attitudes, and practices characteristic of the software engineering profession, including its sociotechnical intricacies.

Building on our previous findings, Figure 2 summarizes the four open codes along two intersecting axial dimensions: Technical vs. Soft Skills and Personal Growth vs. Future Application. This categorization illustrates how experiential learning fosters a dual transformation. By bridging immediate skill acquisition with long-term career development, we highlight the multifaceted benefits of hands-on learning in shaping well-rounded software professionals.

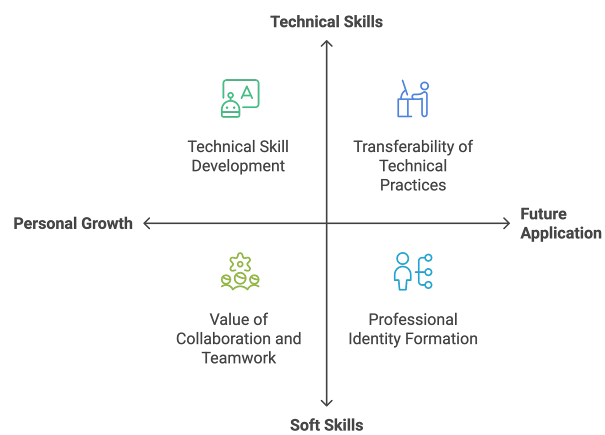


Figure 2: Categorization of learning outcomes.

3.4.2 Perception of the Cyclical Process. This analysis addressed the answers to the questions around Kolb's Experiential Learning Cycle, respectively examining: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation.

Concrete Experience refers to direct experiences and the feelings generated by these experiences in the context of the extension project. When asked whether the practical activities of systems analysis and development in the context of the extension project were important for their learning, 85% of respondents strongly agreed, with the remaining 15% agreeing. Similarly, 90% strongly agreed that the experience was relevant to their professional development.

These consistently high ratings across different dimensions of the learning experience suggest that the project effectively bridged theoretical knowledge with practical application in a way that resonated with participants' educational and career aspirations.

Reflective Observation is related to the ability to reflect on actions and experiences, considering different perspectives. When asked whether they had moments during the project when they stopped to reflect on decisions made and actions taken, 65% strongly agreed and 35% agreed. Furthermore, 85% strongly agreed that reflection on the experience was important for their personal and professional development. The primary sources of reflection reported by participants included personal reflection (50%), discussions with team members (45%), and periodic follow-up meetings (65%). This multifaceted approach to reflection aligns with Kolb's experiential learning cycle, which emphasizes reflective observation as a component of transforming experience into knowledge [37].

Abstract Conceptualization involves the ability to organize experience into a theoretical or conceptual model to solve problems. When asked whether they were able to apply theories and concepts learned in course disciplines during project development, 65% strongly agreed and 25% agreed. Moreover, 95% strongly agreed that relating theoretical knowledge acquired in the classroom to project practice is important. These findings suggest that the project successfully created opportunities for participants to contextualize their academic learning within professional scenarios, thereby enhancing the relevance and transferability of their knowledge.

Lastly, **Active Experimentation** refers to the direct application of acquired knowledge in practical actions, promoting learning through the completion of tasks. Thus, when asked whether they felt challenged to implement solutions to real problems during the extension project, 85% strongly agreed and 15% agreed. Similarly, 90% strongly agreed that practical application (making and testing solutions) was important for their learning . This emphasis on real-world problem-solving reflects the authenticity of the learning experience and its alignment with professional practice. In addition, 95% of participants indicated they would apply what they learned in this project to future work. The qualitative responses to this question reveal multiple dimensions of learning that participants found valuable, including technical skills, project management methodologies, teamwork strategies, and professional communication practices. This high level of perceived transferability suggests that the learning experiences gained through the project were seen as authentic and relevant to participants' future professional contexts.

3.4.3 Lessons Learned. As the coordinating professor, overseeing the extension project provided an opportunity to assess both the benefits and challenges of integrating experiential learning into distance education. In this section, we present a reflective analysis of the primary lessons learned, which are also summarized in Table 1. To do so, we drew on both the final reports written by the students and the professor's perspective, who served as the project manager and product owner, ensuring alignment with educational objectives and stakeholder needs throughout the process. This dual perspective enriched our findings by capturing both the students' lived experiences and the pedagogical and managerial perception of the professor.

Lesson #1: Reflection Transforms Experience into Knowledge

Firstly, one important lesson was the critical role of reflection in student growth. While students actively engaged in software development, their learning moments often stemmed from structured reflection, whether through personal contemplation, group discussions, or formal reporting. This issue reinforced the importance of making reflective practice an explicit component of experiential learning initiatives, rather than assuming it will occur organically. In our case, we implemented different mechanisms to facilitate reflection: periodic team meetings, dedicated chat channels for each squad (as well as one for the entire team), a shared spreadsheet to log weekly activities and tasks completed, a system for tracking participation, and, at the project's conclusion, a final report where students could reflect on their overall experience and perceptions of the project. In line with this issue, one student mentioned that the "*The coordinating professor provided extremely active and continuous assistance through regular follow-up meetings and, most importantly, through the direct channel he built with us through Google Chats integrated into our institutional email. During the regular meetings, the project's progress was presented and, consequently, the professed discussed the prototypes and models developed, providing feedback for improvements in the design and development of the website*".

However, structured reflection improved learning process but also revealed practical challenges, such as balancing project demands with students' other commitments. We also recognize the importance of defining a fixed yet flexible weekly time commitment that aligns with students' realities. Some volunteers struggled to meet the project's default expectation of 12 hours per week, highlighting the need for a more adaptable approach. One common difficulty mentioned by students was managing time effectively, given the balancing act of work, study, and project commitments. Several sprints revealed that some students were unable to meet the planned deadlines. As one student reflected, "*I believe that one of the biggest difficulties was reconciling studies, work and projects. But through these difficulties, we learned to strive every day and improve. And to adapt to each situation we find ourselves in along the way, and each day to apply each new thing we learned to our project*".

Lesson #2: Balancing Technical Mastery with Soft Skills Enhancement

Another key lesson learned was the importance of balancing technical skill development with soft skills enhancement. Since the project was heavily focused on delivering real-world software artifacts, students also frequently encountered challenges related to communication, time management, and project management, which are similar to those in a real-world work environment. Observing their progression, it became evident that structured collaboration practices, such as agile approaches and peer feedback loops, were fundamental in helping them mitigate these challenges. As an instructor, this issue emphasized the importance of embedding structured collaboration strategies to ensure students develop both technical proficiency and soft skills. According to one of the students in his/her final report, "*the main lessons learned during the project involved both technical and personal aspects. In the technical area, I deepened my knowledge of software testing and log monitoring* *tools, programming languages and frameworks, as well as research practices, report development and task management. In the personal area, I developed skills such as time management, communication, teamwork, leadership and emotional intelligence. The project highlighted my commitment to developing technological solutions that have a positive impact on society*".

Another challenge was maintaining effective communication throughout the sprint cycles, despite the team having a dedicated chat channel for discussions. Although the channel aimed to promote collaboration, the absence of strategic in-person interactions and difficulties with asynchronous communication resulted in delays in decision-making. To address this issue, we introduced a rotating communication facilitator role, changing with each sprint, to foster a sense of responsibility and leadership development among students. This strategy aimed to encourage more proactive communication and engagement. However, it became clear that a stronger emphasis on time management strategies would be necessary to improve communication flow and ensure task completion.

Lesson #3: Scaffolding Autonomy and Collaboration for Professional Growth

From a pedagogical standpoint, a primary challenge in this experience was striking the balance between providing sufficient guidance and fostering student autonomy in a remote learning environment. Unlike traditional classrooms where students can seek immediate clarification, our distance education context required more deliberate scaffolding through clear documentation, asynchronous check-ins, and regular meetings. In particular, some students initially struggled with project expectations and workflow management, which emphasized the necessity of providing upfront training on tools such as versioning control, GitHub Project, agile practices, and collaborative practices. For example, one student clarified "*There were technical challenges, such as the initial understanding of specific project concepts and the implementation of good practices in code, which required extra dedication*". Reinforcing this issue, another student mentioned: "*My difficulties were at the beginning when we didn't have efficient communication between the team, the difficulty in knowing if we were doing something new the right way*". Future iterations of this initiative would benefit from a preparatory phase that focuses on onboarding students to these practices and technologies with more detailed information.

Despite these initial hurdles, we also observed that students remained highly motivated by the project's real-world relevance. To ensure success, it was important to structure their learning by providing clear milestones, regular feedback, and structured reflection activities. While distance education inherently presents challenges in creating hands-on experiences, our project demonstrated that careful design can create meaningful practical opportunities in remote settings. Specifically, students in remote learning environments often miss out on organic peer learning and exposure to industry practices. Our approach showed that a well-structured collaborative environment, even in a online setting, can replicate some key aspects of professional team dynamics. Through squad-based work organization, implementation of agile practices, and facilitated team interactions, students developed technical skills and internalized professional behaviors fundamental for their future careers. One student articulated this transformation: "*Professionally, I was able to improve essential skills such as software development, team organization, collaborative work and communication, which were essential to coordinate the group's tasks and ensure that the objectives were achieved. Furthermore, when dealing with scientific dissemination, I understood the importance of making knowledge accessible to society, something that goes beyond the technical aspects and reinforces the social responsibility of professionals. On a personal and civic level, the experience allowed me to realize how teamwork and dialogue are essential for collective projects. The contact with other participants and the coordination between the groups awakened in me a greater sense of cooperation, as I understood the challenges and needs of each team*".

Observing this transformation highlighted the importance of embedding industry-relevant collaborative experiences into distance learning curricula to better prepare students for real-world careers. Our approach provided a bridge between academic knowledge and professional practice, creating a learning environment where autonomy and collaboration reinforce professional growth.

Lesson #4: Empowering Extension Projects as a Bridge Between Sociotechnical Development and Public Impact

Finally, an important lesson was the impact that well-designed extension projects can have in promoting public impact through a sociotechnical development lens. By creating real and publicly accessible software artifacts, students engaged in a process that intertwined technical engineering with social skills. Furthermore, for many students, this project represented their first direct exposure to the principles of open science and scientific dissemination. One student clarified that: "*The greatest learning came from the extension context, when I understood the relevance of projects that connect the university with society. I was able to see the impact of initiatives that democratize access to science, such as dataWASHES, and I learned to work in an environment that simulates collaborative practices, promoting both technical training and citizenship training. This experience reinforced my commitment to the practical application of academic knowledge to solve real problems and generate benefits for the community*".

Therefore, exposing students to solutions that could be used by real users enhanced their sense of responsibility and motivation. Indeed, the turning point occurred when students fully embraced both the responsibility and the opportunity of delivering a meaningful and impactful result. Knowing that their work had the potential to make a tangible impact on the community encouraged them to take ownership of the project and strive for higher-quality results. This perspective aligns with the sociotechnical approach [57], which acknowledges that technological artifacts are embedded within broader social, economic, and cultural systems. As one student noted, "*The development of technical skills, such as solving complex problems and adapting to new tools and methodologies. I learned the importance of working collaboratively, coordinating tasks with the team and overcoming challenges together. In addition, I gained a broader vision of project organization and planning, learning how to set clear goals and meet deadlines efficiently. Another significant learning was the understanding of the social impact of our work,*

Lesson	Challenge	Strategy	Impact
Lesson #1: Reflection Transforms Experience into Knowledge	Lack of structured reflection in student work.	Implemented team meetings, chat channels, shared progress sheets, and final reports.	Enhanced learning through structured reflection, but time commitment challenges persisted.
Lesson #2: Balancing Technical Mastery with Soft Skills Enhancement	Difficulty balancing technical proficiency with soft skills (communication, time management).	Integrated agile practices, rotating communication facilitators.	Improved teamwork, leadership, and time management. Identified gaps in asynchronous communication.
Lesson #3: Scaffolding Autonomy and Collaboration for Professional Growth	Balancing guidance with student autonomy in remote learning.	Clear documentation, onboarding for tools, and milestone-based learning.	Strengthened technical confidence, collaborative skills, and workflow management.
Lesson #4: Empowering Extension Projects as a Bridge Between Sociotechnical Development and Public Impact	Lack of recognition of software's societal role.	Exposed students to real-world open science and public impact.	Increased motivation and responsibility; enhanced awareness of the social impact of software.

Table 1: Summary of Lessons Learned from the Extension Project: Challenges, Strategies, and Impact.

reinforcing the commitment to creating solutions that benefit the community". As we can see, this issue highlights the potential for experiential learning and extension-based initiatives to serve both educational and societal functions, bridging the gap between university coursework and community impact while reinforcing the mutual shaping of technical and social development.

4 Discussion

Our exploration of experiential learning in distance education for software engineering students has revealed findings that speak to both the challenges and possibilities of preparing future software professionals. Through the voices of our students and our reflections as educators, we have had meaningful learning experiences.

Initially, the overwhelming positive response from students (85% strongly agreeing that practical activities enhanced their learning) reinforces the value of well-designed experiential learning in distance education. As one student noted, the project transformed their "narrow view" of software development into a more comprehensive understanding of collaborative professional practice. Our extension project enabled a certain degree of "structured authenticity": learning experiences that mirror professional environments while providing necessary educational scaffolding. This approach addresses the well-documented theory-practice gap in software engineering education by immersing students in industry-relevant workflows while maintaining educational support structures [31].

Moreover, the results indicated that students underwent a dual transformation, which involved enhancing both their technical skills and developing a professional identity. The student who characterized their learning as "*more intrinsic... literally a day-to-day life of an IT professional*" exemplifies this fusion. Through multi-modal reflection opportunities (personal contemplation, peer discussions, and formal check-ins) students processed their experiences and extracted generalizable principles applicable across contexts. This transformation aligns with the concepts of communities of practice [35, 48], where engaging in activities supports the internalization of skills, professional values, and identities.

We also found that the real-world relevance of creating publicly accessible software enhanced student motivation and engagement. One student highlighted how the experience reinforced their "*commitment to the practical application of academic knowledge to solve real problems and generate benefits for the community*". By framing software development as a sociotechnical practice with social implications, the extention project helped students recognize the inseparability of technical and social dimensions in software engineering. This understanding is increasingly critical as software systems become more embedded in societal infrastructure [13].

Despite the positive outcomes, the project also posed operational challenges that required careful management. Time constraints were a recurring issue, as students often struggled to balance project responsibilities with academic and personal demands. Maintaining engagement and alignment in a remote, asynchronous setting proved difficult, even with structured communication strategies. To address these challenges, we relied on tools like Google Spaces and GitHub Issues to surface impediments and coordinate support. We also adapted Scrum practices to fit the context by merging sprint reviews and retrospectives into biweekly checkpoints, omitting daily standups, and rotating facilitation roles to encourage shared leadership. From an organizer's perspective, the eight-month timeline proved adequate for iterative development and deeper student immersion, but it demanded early planning of deliverables, sprint schedules, and team roles. Guided by Kolb's experiential learning cycle, we designed activities that encouraged continuous reflection and feedback. Evaluation combined individual weekly logs, team outputs, and final reflective reports. Flexibility, regular feedback, and well-structured routines were also important to sustaining motivation and collaboration throughout the project.

4.1 Key Takeaways and Future Directions

The findings of this study suggest actionable takeaways for software engineering education. As already known [31], embedding industry-relevant practices throughout the curriculum (from agile methodologies to version control and code reviews) helps students develop professional competencies beyond specific technologies. Similarly, elevating reflection from an implicit assumption to an explicit component of learning mirrors practices like retrospectives and code reviews, creating structured opportunities for students to transform experiences into competencies. The positive response to sociotechnical framing encourages more consistent integration of technical concepts within their social contexts, acknowledging that software development decisions carry social implications that students must learn [8]. For distance education specifically, deliberate design strategies including clear documentation, proper onboarding, and structured communication protocols may help create the social presence necessary for effective remote collaboration.

Looking ahead, other questions also warrant further exploration. For instance, increasing our understanding of how experiential learning shapes students' professional trajectories over time could shed light on its long-term educational impact. Future studies could benefit from incorporating academic performance indicators (e.g., grades, course progression) as complementary sources to better contextualize students' perceptions and engagement. Additionally, given that the SA&D program can also be offered in a face-to-face modality, comparative analyses between distance and in-person formats could illuminate how modality influences the implementation and effectiveness of experiential learning in extension projects.

Moreover, identifying which reflective practices best foster technical expertise versus soft skills development would help tailor these approaches to specific learning objectives. Another avenue consists of investigating how a sociotechnical framing influences students' ethical reasoning could enhance responsible software engineering education, while refining the balance between structured support and student autonomy could improve pedagogical strategies for remote learning. Finally, examining the complementary roles of academic extension projects and industry internships may offer findings into bridging the persistent gap between academia and industry more effectively.

4.2 Limitations

This experience report offers findings into integrating experiential learning and extension activities in distance education, but certain limitations must be noted. First, the study relied on self-reported data from students through questionnaires and reflective reports, which, while relevant, may introduce biases such as social desirability and retrospective interpretation. Triangulation with project artifacts (e.g., final reports) strengthened the validity of findings, but the absence of academic performance data (e.g., grades or course progression) limited a deeper understanding.

Second, the voluntary nature of the project resulted in participant attrition, with some students withdrawing due to time constraints and competing commitments. This issue is an inherent challenge in distance education, but it can limit the generalizability of our findings, as those who remained engaged may represent a more motivated subgroup. The small sample size, drawn from a single public university, and the high dropout rate may also affect the generalizability. We also acknowledge that students' prior experience levels may have influenced how they engaged with and benefited from the project. Investigating strategies to enhance sustained participation could provide more inclusive opportunities.

Finally, the specific context of this initiative (focused on software development for open science and scientific dissemination) may not fully represent to other types of extension projects or disciplines. While the sociotechnical framing provided a rich learning environment, different domains may pose distinct challenges and require alternative pedagogical approaches.

5 Final Remarks

This experience report highlights how integrating experiential learning with extension activities in a distance education context can leverage meaningful professional and academic development. By engaging students in a real-world software development initiative aligned with open science and scientific dissemination, the project provided an opportunity to bridge theoretical knowledge with practical application in the context of a extension project. Methodologically, this study follows a well-defined experience report framework, employing a mixed-methods approach that integrates quantitative survey data with qualitative reflections from students and the coordinating professor. We have transparently addressed the study's limitations, including potential self-selection biases and challenges related to participant retention in distance education settings. Our findings highlight both the benefits and challenges of this approach, offering actionable lessons based on our learning environment and lived experience.

The relevance of this experience report stems from its focus on an underexplored intersection of software engineering education: the role of university extension projects as a mechanism for experiential learning in distance education. While prior research has examined active learning strategies and industry collaborations, our work demonstrates how academic extension can serve as an alternative or complementary avenue for students to gain hands-on experience in remote settings. By situating the project within a sociotechnical perspective, we also highlight the importance of exposing students to real users and societal challenges, fostering both technical proficiency and professional growth. We noticed that the emphasis on real users and tangible impact reinforced students' sense of responsibility and motivation. Furthermore, our experience revealed challenges inherent to distance education, particularly regarding time management, engagement sustainability, and balancing academic, professional, and personal responsibilities. The flexible structure enabled students to adjust their participation levels, but the experience highlighted the need for strategies to address three key challenges: time management, communication, and balancing guidance with autonomy. However, we also found that experiential learning emerged as a critical element in this process, helping students mitigate the complexities of collaborative work, but also reinforcing their lessons in practice.

ARTIFACT AVAILABILITY

To ensure verifiability, the data supporting this study are openly accessible through our repository [4].

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