Building Pathways to Professional Competence: Microcredentialing and Certification for Student Teaching and Research Assistants

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Abstract

Engineering graduates enter a workforce that demands more than technical proficiency. Employers consistently identify gaps in professional competencies - financial literacy, communication, project management, and leadership skills that academic curricula often address only peripherally. XXXX has developed a microcredentialing framework to address these gaps for student teaching assistants (TAs) and grant-funded research assistants (RAs). This Work-in-Progress paper presents the framework design, the research methods used to identify competency gaps and inform content development, and preliminary findings from the pilot phase. The approach combines external certifications with internally developed coursework, integrated into the Engineering Education & Leadership (E-Lead) degree program curriculum. The flagship internally developed course - a Profit and Loss Analysis microcredential designed for STEM students - is currently being piloted in two cohorts, comprising 42 students in total. Pre-assessment data establish baseline competency measures, with post-assessment results expected following cohort completion in May 2026. Early findings confirm both student interest in professional development topics and the assessment instrument's ability to differentiate between novice and experienced performance levels.

1. Introduction

The gap between engineering education and workforce expectations is well documented [1]. While programs develop strong technical competence, employers report that graduates often lack essential professional skills for workplace effectiveness [2], particularly in communication, financial acumen, project management, and leadership. XXXX supports undergraduate and graduate researchers through teaching and research assistantships funded by the XXXX grant. Over four years, program leadership consistently observed that students, while technically strong, struggled with professional competencies that differentiate candidates in the job market. This observation aligns with feedback from the Center's Industry Advisory Board (IAB), whose members across engineering and industry sectors identified similar gaps in entry-level candidates [3]. In response, the Center developed a microcredentialing framework to complement academic training with verifiable professional development. This Work-in-Progress paper presents the framework's design rationale, research methods, implementation, and preliminary pilot findings.

2. Research Methods

The microcredentialing initiative emerged from three converging sources of data: longitudinal observations from student mentoring, structured discussions with the Industry Advisory Board, and direct surveys of the student population. This section describes the data collection methods for each source and how the resulting findings informed the framework's design.

Mentoring Observations.

Program managers working directly with TAs and RAs noted recurring challenges over four years of grant-funded mentoring activity [3]. Two program managers and an average of five TA/RA students per year, working with 373 freshman students over four years, documented

observations through transcribed meeting notes, monthly team meetings, and annual program reviews. Students consistently demonstrated strong research capabilities but struggled when asked to communicate findings to non-technical audiences, manage project timelines, or understand the business context of their work. These accumulated observations informed the initial scope of the microcredentialing effort by identifying communication, project management, and financial literacy as priority competency areas.

Industry Advisory Board Input.

The Center's IAB serves as a community partner, aligning academic programming with current workforce expectations. The 11-member board represents education, aerospace, manufacturing, defense, entrepreneurship, and government, with members selected for industry relevance, regional representation, and sector diversity. Meeting three times annually, the IAB discusses workforce readiness, responds to student-submitted questions, and identifies gaps in graduate preparation. Sessions are recorded and transcribed for Center use. These discussions consistently emphasize professional competencies—rather than technical skills—as the key differentiator in entry-level candidates. Beyond advisory input, IAB members contribute through guest lectures, mentorship, resume reviews, and workshops. Their input directly informs microcredential topic selection, ensuring alignment with hiring criteria while providing students with exposure to industry perspectives.

Student Surveys.

Informal surveys administered to the student population gauged interest in potential professional development topics. 336 students from a population of 373 (90%) responded. The survey presented Likert-scale interest ratings, ranking exercises, and open-ended questions. Students expressed interest across multiple areas, including professional communication, leadership, resume preparation, and technical tools. Financial literacy emerged as the highest-priority topic, prompting the development of dedicated coursework in this area. This student-driven prioritization ensures that the microcredentialing framework addresses genuine learner interests rather than imposing externally determined content. Table 1 summarizes how each data source informed specific design decisions within the framework.

Table 1. *Data Sources and Resulting Design Decisions*

Data Source	Key Finding	Design Decision	Framework Component
Mentoring Observations (4 years)	Students struggle with communication, project management, business context	Prioritize professional competencies over additional technical content	Overall framework scope and competency selection
IAB Input	Professional skills differentiate entry-level candidates	Align topics with hiring criteria; adopt recognized credentials where available	Lean Six Sigma external certification pathway
Student Surveys	Financial literacy ranked highest priority	Develop custom P&L Analysis course as flagship microcredential	Internally developed coursework

3. Framework Design

The microcredentialing framework employs a hybrid approach, combining external certifications with internally developed coursework. This design reflects a deliberate build-versus-buy analysis for each competency area. Table 2 summarizes the framework's structure, mapping competency areas to credential types, delivery mechanisms, and current implementation status.

Table 2. *Microcredentialing Framework Summary*

Competency Area	Credential Type	Provider	Delivery Mechanism	Status
Process Improvement	External Certification	Lean Six Sigma Institute (LSSI)	LSSI platform; White, Yellow, Green Belt levels	33 Active students enrolled; 22 WB, 13 YB, 2 GB completions
Financial Literacy	Internal Microcredential	XXXX (developed in-house)	SCORM module via LMS; integrated into EL 1301/1402	Piloting with 42 students, 2 cohorts
Communication, Project Mgmt, Technical Tools	TBD	TBD	TBD	Planning phase

External Certifications.

For competency areas with established industry standards and recognized credentialing bodies, the Center leverages external certifications rather than developing proprietary content. The primary example is Lean Six Sigma certification through the Lean Six Sigma Institute (LSSI). The Center provides licenses for students to pursue White, Yellow, and Green Belt certifications - credentials with direct recognition in engineering and manufacturing sectors. LSSI administers all coursework and assessment, issuing certificates upon successful completion. This approach provides students with externally validated credentials while avoiding duplication of well-established training programs.

Internally Developed Coursework.

For competency areas where existing external offerings do not align with student needs or institutional context, the Center develops custom microcredentials. The flagship example is a Profit and Loss (P&L) Analysis course designed specifically for engineering students who lack business or accounting backgrounds. This course addresses one aspect of the financial literacy gap identified as the top student priority in surveys. Internal development allows precise tailoring of content, examples, and assessment to the engineering context while maintaining mastery-based learning design principles, including multi-layered assessment, mastery thresholds for progression, and capstone integration (detailed in Section 4). This approach aligns with emerging definitions of microcredentials as representations of learning focused on discrete competencies [4].

Curriculum Integration.

Rather than positioning microcredentials as standalone optional activities, the framework integrates them into the Engineering Education & Leadership (E-Lead) major, an ABET-accredited degree program at XXXX [5]. E-Lead encompasses multiple engineering concentrations - aerospace, biomedical, civil, computer, electrical, mechanical, and metallurgical

engineering - unified by a four-year sequence of leadership and professional development courses (the EL series) that distinguishes the program from traditional engineering degrees. The microcredential framework integrates into EL 1301 and EL 1402, the first-year courses in this sequence, providing a natural entry point for professional competency development. Students complete designated microcredentials as part of their required coursework, ensuring broad participation and enabling assessment within the academic grading structure.

Institutional Badging.

To maximize the value of internally developed microcredentials, the Center submits coursework to the XXXX Microcredential Guidance Committee for official recognition. Approved microcredentials receive institutional digital badges, providing students with portable credentials that carry university validation. The P&L Analysis course was given unanimous approval by the Microcredential Guidance Committee to receive this designation and is included in the University microcredential catalogue.

4. Case Study: P&L Analysis Course

The Profit and Loss Analysis for STEM Students course illustrates the Center's approach to internally developed microcredentials. The course is currently being piloted with two cohorts totaling 42 students, with cohort completion expected in May 2026. Designed as an online, self-paced module developed and deployed in SCORM (Shareable Content Object Reference Model) format for integration with a Learning Management System (LMS), the course addresses a specific competency gap: engineering students' limited exposure to financial statement analysis and business decision-making frameworks.

Course Structure.

The course comprises eight modules covering fundamental P&L concepts, including revenue recognition, cost structures, margin analysis, and operational interpretation of financial results. Content is designed for students without accounting backgrounds, using engineering-relevant

examples, fictional but realistic case study companies, and avoiding unnecessary financial jargon. The self-paced format allows students to progress according to their schedules while maintaining structured learning objectives for each module.

Assessment Architecture.

The course employs a multi-layered assessment strategy designed to measure both knowledge acquisition and retention. The assessment design reflects mastery learning principles [6], requiring demonstrated competence before advancement into more complex material.

Pre-Assessment: A 20-question baseline assessment administered immediately after the course introduction, before students engage with instructional content. The assessment covers material from all eight modules and establishes each student's starting competency level. Based on preliminary validation testing and initial cohort results, students without financial backgrounds are expected to score in the 30-50% range.

Module Quizzes: Each module concludes with a 25-30 question assessment using multiple choice, true/false, and other objective formats. Students must achieve 80% or higher to proceed to the next module.

Post-Assessment: Upon completing all modules, students retake the identical 20-question baseline assessment. Comparison of pre- and post-scores will provide a direct measure of learning gains attributable to the course intervention.

Capstone Integration.

The course design includes a capstone analysis project in which students interpret a fictional but realistic P&L statement and articulate reasoned conclusions about business performance. Unlike objective assessments, the capstone evaluates students' ability to apply analytical reasoning rather than recall specific facts. Because this assessment requires human grading and evaluates interpretive rather than factual knowledge, it is positioned within the EL 1301/1402 course structure rather than the self-paced LMS module. This design allows the microcredential to certify foundational knowledge while the credit-bearing course assesses application and synthesis.

5. Preliminary Findings and Lessons Learned

While the microcredentialing framework remains in early implementation, preliminary findings from the completed course development and initial pilot deployment inform ongoing work.

Baseline Assessment Results.

Pre-assessment data have been collected from 22 TAs and RAs participating in the Center's grant-funded mentoring program, yielding a mean score of 53%, with individual scores ranging from 30% to 85%. The highest score was achieved by a student minoring in finance, suggesting prior financial coursework meaningfully impacts performance.

Additional pre-assessment data have been collected from a second pilot cohort of 20 students enrolled in EL 1301/1402. The mean pre-assessment score was 51%, with individual scores ranging from 20% to 75%.

These results confirm that the assessment effectively differentiates between novice and experienced performance and that the target population - engineering students without business training - begins at the expected competency floor. Post-assessment scores, collected upon completion of the pilots, will provide the pre-/post-comparison necessary to measure learning gains attributable to the course intervention.

Student Interest Alignment.

Survey results demonstrated strong student demand for the planned microcredential topics, with financial literacy ranking highest among all options. This finding validated the decision to prioritize the P&L Analysis course and suggests that student engagement may exceed initial projections. The explicit connection between student-expressed interests and course development distinguishes this initiative from top-down professional development mandates.

External Certification Logistics.

The Lean Six Sigma certification pathway requires ongoing coordination to monitor student enrollment and completion through the external Lean Six Sigma Institute (LSSI) platform. To date, 33 students have enrolled across three certification levels. Of the 33 students enrolled in White Belt, 22 completed certification; 13 of 17 students completed Yellow Belt; and 2 of 9 students completed Green Belt. These results indicate strong participation in the introductory certification levels, with lower completion at the more advanced level. Future reporting will examine overall completion trends and student feedback on the external certification experience.

Design Considerations.

Development of the P&L course revealed several design principles applicable to future microcredential development. Assessment questions must test only explicitly taught content - questions requiring inference beyond presented material undermine the validity of mastery-based progression. Content examples must be relatable to the targeted learner to maintain student engagement; generic business examples fail to connect with the target audience. The 80% mastery threshold for module progression, while demanding, reflects mastery learning principles that emphasize demonstrated competence before advancement [6]. These principles, grounded in Bloom's learning for mastery framework, will guide the development of subsequent microcredentials.

6. Future Work and Conclusion

The microcredentialing framework will continue to evolve based on pilot results and ongoing gap analysis. Immediate next steps include collecting post-assessment data from the initial P&L Analysis cohort in May 2026, comparing pre-/post-scores to measure learning gains, and evaluating capstone submissions for qualitative evidence of applied financial analysis skills. These findings will guide refinements to course content and assessment instruments and will be presented at the 2026 ASEE Annual Conference.

Additional microcredentials in communication, project management, and technical tools are currently in development, informed by student survey priorities and Industry Advisory Board guidance. While the current pilot serves the E-Lead student population, future work will examine the scalability of this model to larger engineering programs, including implications for course delivery, grading capacity, and faculty support.

Assessment efforts will also expand to include longitudinal tracking of internship placement, employer feedback, self-reported professional confidence, and the relationship between microcredential completion and academic performance.

This Work-in-Progress represents an early effort to address workforce preparation gaps in engineering education through a hybrid model that combines external certifications, custom-developed coursework, and institutional digital badges. Preliminary findings—including baseline assessment results and strong student interest—suggest a promising foundation for continued development. Full pre-/post-assessment data following the May 2026 cohort completion will provide clearer evidence of the framework’s effectiveness in strengthening professional competencies among engineering students.

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