Interdisciplinary Reflections on Engineering Technology Research

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Abstract

This paper builds upon the shared experiences of an NSF Collaborative project that investigated academic and career pathways for engineering technology students. While the initial publication focused on the study's findings from Phases 1 and 2, this follow-up highlights the collaborative processes and interdisciplinary contributions that enabled the project's success.

The study brought together researchers from two institutions, each offering expertise in engineering education, survey design, and data analysis. Team members played critical roles in shaping the research design, refining the Phase 2 survey instrument, and interpreting data to generate actionable recommendations. This paper details how the team coordinated across institutional boundaries, leveraged diverse disciplinary perspectives, and maintained alignment with NSF priorities throughout the project lifecycle.

A central feature of this paper is the inclusion of individual reflections from each researcher, offering insight into how participation in the project contributed to their professional growth, expanded their understanding of interdisciplinary collaboration, and deepened their engagement with STEM education research. These personal narratives provide a rich, qualitative layer to the study, illustrating how collaborative research can foster learning, adaptability, and innovation among team members. The paper also draws on key lessons from managing a multi-phase, multi-institutional NSF study, offering insights for future grantees seeking to build and maintain productive research teams.

Keywords: Interdisciplinary collaboration, STEM education research, Engineering technology pathways, NSF-funded research, Collaborative research teams, multi- institutional study, Researcher reflection

Introduction

This work extends a 2023 NSF-funded collaborative project that examined academic and career pathways for engineering and engineering technology students. This work focuses on the collaborative effort behind the research and the interdisciplinary contributions that shaped the project from start to finish.

The project team represented several institutions and brought together complementary strengths in engineering education, survey development, and data analysis. Each member contributed to refining the study design, strengthening the Phase 2 survey instrument, and

interpreting the resulting data to support meaningful recommendations. This paper describes how the team coordinated across institutions, integrated different disciplinary perspectives, and remained aligned with NSF expectations throughout the project.

An important part of this paper reflects on the researchers' experiences—both through documented observations and informal reflections. These insights highlight how participating in a multi-phase study fostered professional growth, broadened understanding of interdisciplinary collaboration, and deepened engagement with STEM education research. By sharing these perspectives, we add a qualitative dimension that illustrates how collaborative research environments promote learning, adaptability, and innovation. The paper closes with lessons learned about managing a large, distributed research team and offers practical guidance for others undertaking similar NSF-funded work.

Experiences of Researchers and Students

The collaborative nature of this NSF-funded project extended across two institutions, each navigating unique challenges while contributing to the study's overall success. At one institution, the team relied heavily on undergraduate students whose participation was shaped by class schedules, priority conflicts, and competing academic obligations. These constraints required flexibility in task assignments and timelines, as undergraduates balanced research responsibilities with coursework and extracurricular commitments. Despite these challenges, their involvement provided students with valuable perspectives and fostered early engagement with engineering education research.

In contrast, the second institution primarily engaged graduate students who were simultaneously managing their own research projects. While these students brought advanced methodological skills and deeper disciplinary knowledge, their independent research priorities occasionally limited their availability for collaborative tasks. This dynamic highlighted the need for clear communication and adaptive planning to ensure alignment with project goals while respecting individual academic trajectories. This causes tension and often a slower-than-anticipated progression of the work.

The current analysis reflects a more mature and structured collaboration, albeit very independent of one another. Initial observations emphasized logistical hurdles and role ambiguity; however, this follow-up demonstrates how iterative coordination and shared accountability evolved over time. Lessons learned include the importance of establishing realistic expectations for student contributions, including buy-in of all faculty, leveraging institutional resources to mitigate scheduling conflicts, and fostering a culture of flexibility that accommodates diverse academic commitments.

Overview: Two Institutions, One Project—Many Realities

The collaborative structure of this NSF-funded project deliberately spanned two institutions,

with each site organizing its own workflows, mentoring practices, and timelines while remaining aligned to shared objectives. This distributed model reflected both necessity and opportunity: necessity because each institution had distinct calendars, resource constraints, and trainee demographics; and opportunity, because differences in local practices stimulated complementary approaches to training, data collection, and interpretation. What emerged was a living demonstration of how multi-institutional research operates in practice: messy at times but ultimately generative, especially when undergraduate and graduate roles evolve across the work's phases.

Institution A: Undergraduate Centered Participation Amid Conflicts and Priorities

At Institution A, undergraduate students formed the core of the day-to-day project activity. Their participation, though enthusiastic, was shaped by the realities of course schedules, exams, reserved lab time, and competing commitments such as capstone projects and club responsibilities. Two undergraduates were simultaneously pursuing field-aligned internships, enriching the project with current industry perspectives (e.g., the vocabulary used by practitioners, typical workflow constraints, and quality expectations for applied work). However, these internships also introduced new scheduling constraints, shift management, supervisor sign-offs, and on-site obligations, which reduced the research team's real-time availability at critical points (such as survey piloting windows and data cleaning deadlines).

This tension prompted the team to adopt several practical accommodations. First, weekly project meetings were split into a “core” synchronous session and a “flex” asynchronous checkpoint, allowing students who were on shift or in lab to contribute updates and questions via shared documents. Second, task granularity increased: rather than one student being responsible for an end-to-end activity (e.g., piloting → feedback consolidation → revision), responsibilities were broken into smaller, time-bound micro-tasks. This modularization kept progress visible and minimized bottlenecks.

Despite constraints, undergraduates at Institution A reported substantive learning gains. They described growth in **research literacy** (reading methods sections, understanding operational definitions, distinguishing constructs from indicators), **data practices** (file versioning, consistent variable naming, and the importance of codebooks), and **ethical awareness** (why participation must be voluntary, how privacy is maintained, and what “minimal risk” means in an IRB context). Several students specifically noted that balancing internships and research required them to adopt more deliberate workflows, “planning the work and working the plan,” which they later applied both in class and at their internship sites.

A notable milestone during the project was the **transition of an undergraduate into graduate school at another institution**. Rather than severing ties, the team re-scoped this student’s contributions to fit their changing role and location. They shifted from hands-on

data collection to targeted analytical and editorial work, especially as this student was the first author on one of the publications that took longer to navigate the publication review process. This student is consulted only regarding final edits and issues with the paper they are the primary author on. A practical pathway for maintaining engagement when student trajectories change, identifying activities that leverage their growing skills and provide asynchronous modalities that respect new schedules.

Institution B: Graduate-Led Contributions with Independent Research Demands

Institution B drew primarily on graduate students whose own research programs ran in parallel to this project. These students contributed expertise in advanced methods (e.g., item reliability checks, descriptive and exploratory analysis strategies), while also managing dissertation milestones, advisor expectations, and funding obligations. At times, independence was an asset: graduate researchers could rapidly prototype analytic pipelines and articulate methodological trade-offs. At other times, independence became a constraint: when personal research deadlines coincided with conference submissions or proposal defenses, availability for collaborative tasks dipped, and coordination required extra care.

Midway through the project's timeline, **one additional graduate student joined, and another left** Institution B's team. This late addition reshaped capacity and morale. The newcomer brought fresh energy to documentation practices, drafting standard operating procedures for survey cleaning, adding templates for analytic memos, and championing a "decision log" that recorded the rationale behind instrument changes.

At Institution B, faculty members assumed substantially increased responsibilities, including additional teaching loads and graduate student advising, following the loss of colleagues during the 2023–2024 academic year. This unavoidable redistribution of duties led to a corresponding decline in research productivity, including slower progress on manuscripts.

Graduate students at Institution B articulated specific learning outcomes that differ from those at Institution A. They emphasized **cross-disciplinary translation**, **stakeholder communication**, and **research management.** Several noted that participating in a funded, multi-institutional project sharpened their awareness of project governance, from aligning NSF priorities to implementing equitable authorship practices.

Coordination Mechanics: Bridging Autonomy and Alignment

Although each institution largely operated on its own cadence, the project relied on cross-institutional coordination protocols to ensure data integrity and coherence during early comparisons. This had varying moments of strain as one institution worked toward shared results, and the other did not, with this shifting as the project progressed.

- **Shared Artifacts and Living Documents**
  The teams used common templates for survey item banks, codebooks, and memo structures. This provided a “lowest common denominator” for interoperability and made it easier to merge contributions without losing individual identity.

- **Role Clarity and Task Modularization**
  Roles were clarified in terms of functions (design, data, analysis, dissemination) rather than titles (undergraduate, graduate, PI), thereby reducing implicit hierarchies around who “should” perform certain tasks. Modularization of work, introduced at Institution A for scheduling reasons, improved throughout and created more entry points for undergraduate students.

- **Dual Track Check Ins**
  The project adopted both synchronous meetings (for complex decisions and relationship building) and asynchronous channels (for routine updates and artifact exchange). This mix was essential given internships, class conflicts, and dissertation cycles. It also modeled professional norms from industry, providing a better understanding of how those outside academia work.

Learning Gains: What Students Say They Took Away

Across both sites, students reported learning in three broad categories:

- **Methodological Competence**
  Undergraduates learned what it means to build and revise a survey instrument, specifically how wording affects reliability, how response options shape interpretation, and how to handle partially completed responses [3].

- **Professional Practices**
  Students grew more adept at estimating effort, flagging risks early, and communicating status in ways that helped the team plan around constraints. Several noted that these practices are “transferable currency” across technical roles, whether in industry or academia [4].

- **Identity Formation and Confidence**
  Many undergraduates reported that participating in funded research alongside graduate students and faculty legitimized their sense of belonging in research [5].

Challenges: What Made the Work Hard

The project confronted predictable and useful frictions:

- **Calendar Misalignment**
  Different academic calendars and exam periods created periods of uneven availability. The remedy was proactively scheduling around known "blackout windows" and for Institution A to adopt asynchronous (GroupMe) and synchronous (virtual meetings) checkpoints to keep momentum.
- **Competing Priorities**
  The team responded by re-scoping deliverables and emphasizing high-impact activities (e.g., instrument revisions or data merges) during narrow availability windows.
- **Versioning and Traceability**
  With multiple editors, keeping artifacts synchronized was challenging. Establishing a standard file naming schema, maintaining a change log, and doing periodic "merge reviews" reduced confusion and ensured traceability.
- **Emotional Labor and Motivation**
  Students sometimes felt stretched between roles. To address this, mentors normalized honest check-ins, celebrated small wins, and tied tasks to visible downstream effects.

Comparison to Prior Paper: Same Cohort, Later Stage

Last year's paper captured the cohort at an earlier project stage, with greater emphasis on **startup frictions** including role ambiguity, initial tool selection, and early coordination experiments [2]. In contrast, this follow-up shows the operationalization of lessons learned: clearer roles, a stable artifact ecosystem (templates, codebooks, decision logs), and refined mentorship routines that made cross-institution collaboration more predictable. Where the earlier account highlighted the effort required to convene a workable team structure, this analysis demonstrates the payoffs of persistence: modular workflows that absorb scheduling shocks, reciprocal mentoring, and the ability to onboard a new graduate student midstream without derailing progress [2].

While the prior paper emphasized the costs of competing student priorities, the current phase documents how those same pressures catalyzed professional growth. Internships, for example, were initially framed as time drains; students now describe them as learning accelerators that clarified expectations, improved communication discipline, and provided practical examples for iterating survey wording and interpreting results. The undergraduate who transitioned into graduate study at another institution became a valuable bridge

contributor, demonstrating that continuity can be preserved when roles adapt to the student's new context.

Practical Takeaways for Multi-Institutional Research Teams

Several implementable practices emerged from the experience of this team; they are summed up in the following:

- **Design Roles Around Work, Not Status**
  Assign by function (design, data, analysis, dissemination) to maximize flexibility and learning opportunities across ranks,

- **Modularize High Value Tasks**
  Break deliverables into atomic units that can be picked up during narrow availability windows, and maintain a public queue.

- **Institution Aware Cadence**
  Map academic calendars early, declare blackout periods, and plan milestones around them.

- **Reciprocal Mentoring**
  Create intentional structures that allow undergraduates and graduate students to teach and review each other's work.

- **Artifact Governance**
  Use templates, codebooks, change logs, and decision logs to make the project auditable and sustainable. Save the team in at least one secure space and make the rest accessible in a secure shared drive.

- **Continuity Planning for Student Transitions**
  When students move institutions or roles, pivot them to tasks that leverage their emerging strengths and can be done asynchronously.

Closing Reflection: Collaboration as a Learning Engine

Viewed in total, the two-institution model: undergraduates navigating class and internship constraints at one site; graduate students balancing independent research at the other. This did more than complete a study; it **created a learning environment where** students and researchers sharpened skills essential to contemporary STEM education research. The late addition of a graduate student strengthened analytic throughput and documentation, while also causing some confusion. Undergraduates' transition into graduate school demonstrated how

continuity can be maintained through thoughtful role redefinition. Compared to last year's account, this illuminates how teams mature: problems persist, but solutions become routinized; autonomy remains, but alignment grows more durable. The result is a collaborative engine capable of generating both **rigor** and **growth** for the project and for the people who make it happen.

The data was analyzed using Enterprise CoPilot to verify the sorting of information and organize the sections of the paper, and Grammarly was utilized to check the spelling and punctuation of this document.

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