# Interdisciplinary Pedagogy, Integrated Curriculum, and Professional Development

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**Presenter Information**

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**Abstract**
The challenges involved in facing and solving the most pressing global problems of the 21st century will involve collaboration and critical engagement from multiple disciplines. Interdisciplinary education and the critical skills it can teach—innovation, team-based collaboration, and effective communication, among many others—are crucial to preparing current students for their futures as professional problem-solvers.

We introduce an integrated pedagogical approach between three introductory courses at Purdue University: *Design Thinking in Technology* (Tech 120), *English Composition* (English 106), and *Fundamentals of Speech Communication* (Com 114). Instructors and administrators in all three of these programs are working together to reinforce the valuable and important connections between STEM and Humanities work. Along with an overview of the development and implementation of this integration, we present a summary of findings from our ongoing assessment of the program. The integration has the most beneficial effects on students' sense of community, which in turn significantly impacts their performance on team projects. When STEM and Humanities instructors and faculty share goals and spend time innovating together, the potential benefits to students and to the future of engineering education overall are clear.

## Introduction

This paper introduces an integrated pedagogical approach between three introductory undergraduate courses at Purdue University. This Integrated First-Year Experience program, specifically designed for first-year Technology students, applies essential skills and concepts from both humanities and STEM fields to realistic global problems in an effort to give students' grounded, context-based experience practicing empathetic, human-centered design and critical thinking. This large-scale cross-college collaboration was motivated largely by instructors' widespread (although for the most part anecdotally supported) sense that Technology students often seem to struggle with communicating, whether in writing or formal presentations. The ability to clearly and effectively express innovative design ideas to specific audiences is key to success in many STEM fields, and communication skills and critical thinking are highly valued by employers. However, reports recognize significant skills gap between college graduates' abilities in these areas and technology industries' expectations [1] [2]. Innovatively integrating

Polytechnic and Liberal Arts disciplines at the classroom level will potentially address these skills gaps and give students' English and Communication assignments more realistic contexts beyond the more abstract academic settings where students in these courses often work. The critical skills of audience awareness, clear communication, innovation, and effective team-based collaboration may be more easily learned and retained within an interdisciplinary pedagogical framework. Particularly because the challenges involved in facing the most pressing global problems of the 21st century will require critical engagement and collaboration from multiple disciplines, such interdisciplinary pedagogy is a worthwhile endeavor. This paper describes how an integration initiative at Purdue University has been implemented over three full academic years and discussing the measurable values and complex challenges of bringing separate disciplines and colleges together.

The Integrated First-Year Experience is meant to reinforce the valuable and important connections between STEM and Humanities work and to break down some of the barriers between these disciplines. While more traditional university models draw clear disciplinary divisions between the coursework and plans of study for students in different majors, there is a recognition among education scholars that interdisciplinary pedagogy can improve student learning overall. Existing pedagogical developments and research have begun to demonstrate the potential power of interdisciplinary pedagogical integration and interdisciplinary curricula to increase knowledge transfer and give students more valuable educational experiences. As [3] noted, "to prepare future engineers to work in a global environment amidst the increasing specialization of knowledge, engineering schools are emphasizing projects done by multidisciplinary teams, are paying greater attention to ethics and societal impact, and are focusing on better communication" [3, p. 361]. Cross disciplinary pedagogies may more effectively reinforce the crucial relationships among design thinking, communication, and ethics.

Many types of integration programs, among and across engineering and other disciplines, have been studied; some are rooted within Engineering, some involve larger STEM programs, and others are connected to Humanities-based writing-intensive or writing-in-the-disciplines programs [4–15]. One form these integration efforts commonly take is that of a project-based capstone course like those described by [9] and [12]. In such courses, advanced students may share classroom space and meeting times, work together on team projects, and receive mentorship from engineering and non-engineering faculty. In contrast to the senior end-of-college capstone course, [16] observed an increase in the analogous "corner-stone" course, designed for first-year students. These courses are more foundational, introductory courses, often "motivated by an awareness of the curricular disconnect with first-year students who often did not see any engineering faculty for most of their first two years of study" [16, p. 103].

Other scholars have also noted the positive impacts of First-Year Seminars and similar introductory cornerstone courses on students' learning, particularly collaborative learning and connectedness [15] [17], as well as on students' self-efficacy and optimism [18] [19], and sense of involvement in communities, [7] [8] [10] [20] [21]. A National Survey of First-Year Seminars from 2006, cited in [7] reports that campuses implementing First-Year programs see "increased satisfaction with faculty and the institution, improved retention to the sophomore year and persistence to graduation, increased involvement in campus activities and use of campus

services, increased out-of-class student/faculty interaction, and improved academic ability and grade point average" [7, p. 78]. In [15] it was reported that students in an integrated two-quarter Engineering Design and Communication course sequence produced higher quality reports and presentations. Faculty teaching in this course sequence also reflected that it was the "most rewarding teaching they've done" and that despite the extra work, "based on the feedback we receive and the high quality of the work that EDC freshmen are producing, we argue that an interdisciplinary course like design and communication is a successful model worth emulating" [15, p. 346]. These studies and reports provide a sense of just how beneficial introductory cornerstone-type courses can be. With an additional focus on interdisciplinary STEM and Humanities collaboration and connection, connecting curricula across university colleges, the administrators and instructors from the Polytechnic Institute and the College of Liberal Arts at Purdue University aim to use this integration program to spur measurable improvements in more students' composition, communication, and critical thinking habits. Administrators and instructors within all 3 departments also hope the integration will improve students' learning in all disciplines, increase academic engagement overall, and create a stronger sense of community among first-year students.

The Integrated First-Year Experience at Purdue University prioritizes an "integrated, holistic approach to coursework," "innovative learning environments," and "a context-rich application of English, Communications and Technology" [22]. The integration emphasizes common ground and goals shared by humanities and STEM disciplines, thoughtfully reinforcing the importance of all these skills in realistic, project-based design contexts. Here, we describe and document the implementation of this integrated approach to teaching introductory technology, composition, and communication courses. Following an overview of the motivation, history, and timeline of the Integrated First-Year Experience, the paper summarizes the ongoing research and assessment efforts connected to the program.

**Three courses, one Integrated First-Year Experience**
The Integrated First-Year Experience brings together three introductory courses at Purdue University, all three of which are required for students majoring in any of the Polytechnic Institute's seven departments [23]. The courses are as follows:
- *Introductory Composition (English)*
- *Fundamentals of Speech Communication (Com)*
- *Design Thinking and Technology (Tech)*

Administrators from departments in the College of Liberal Arts and the Polytechnic Institute collaboratively planned and prepared for this integration program in the months leading up to the 2015–2016 academic year, outlining ways in which the Tech course's curriculum and assignment sequence might overlap meaningfully with those of the English and Communication courses. Program administrators collaboratively discussed and developed initial outlines and structures that would facilitate curricular overlap and connection across these courses. As instructors from all three departments were assigned sections within the Integrated First-Year Experience, they were encouraged to meet regularly and discuss ways of creating synergy among important concepts and activities in their courses. The flexible teaching partnerships among instructors were meant to foster a more effective and grounded environment in which students

could then learn critical design thinking, multimodal composition, writing, and oral presentation skills.

While program administrators supplied some big-picture framework for the integration, each set of instructors decided how to apply connections within the program's framework and goals, based on their own teaching style, pedagogical approach, and insights from their individual classrooms. Some Design Thinking instructors, for example, included carefully designed in-class activities that helped students apply concepts of effective communication. Some instructors in English or Communication assigned essays or speeches that incorporated the technological or design-based topics covered in Design Thinking. Other instructors planned shared co-teaching events where instructors would join each other's classrooms to discuss or demonstrate connections across two or more courses.

All three courses' curricula focus on helping students learn and practice developing ideas and content that (whether in written, vocal, or other modes) clearly addresses the needs of specific audiences and users. In *Fundamentals of Speech Communication,* students practice and improve their oral communication skills by planning, rehearsing, and presenting for feedback informative and persuasive speeches. In *Introductory Composition*, students are asked to create written and multimodal compositions and to analyze and critique the compositions of others. Students in *Design Thinking and Technology* practice the design process to research, develop, and propose solutions to grand global engineering problems. The crucial value of teamwork and of ethical, human-centered design are key principles students should come away with at the end of the course.

Table 1: Structure and Characteristics of Three Integrated Courses

| Example Meeting times | Courses & Characteristics | |
|---|---|---|
| 10:30am 50 minutes 2 days/week | Design Thinking in Technology (Tech) 40–45 students standard, but flexible syllabus based on program outcomes | |
| 11:30am 50 minutes 3 or 4 days/ week | Introductory Composition (Engl) 20 students instructors create individual syllabi based on common outcomes | Fundamentals of Speech Communication (Com) 20–25 students standard, strict syllabus based on program outcomes |

Each Design Thinking section functions as the center of a "trio" of courses; Table 1 illustrates the general structure of courses and how the program connects them. For example, a student enrolled in the Integrated First-Year Experience will take either their English or Communications course with the same group of students also enrolled in a Design Thinking course. The larger Design Thinking course comprises one full class of English students and another full class of Communications students. Instructors in Design Thinking worked with instructors in English and Communications to collaboratively explore and implement ways of connecting and reinforcing the curriculum of their courses.

Now in its third year, the Integrated First-Year Experience continues to be refined in response to instructors' and students' feedback. Significant details and developments from each year are described below, followed by a summary of our research findings thus far.

**Year 1: 2015–2016**
For the Integrated First-Year Experience's very first semester, 13 sections of Design Thinking were offered, each paired with both an English and a Communication course. Outside of the integration program, regular "non-integrated" sections (3 of Design Thinking and many multiple English and Communication) were also offered, as usual. Although the majority of all Design Thinking sections were integrated during Fall semester not all freshmen students within the Polytechnic Institute were able to select this option; in total, the integration program this year included over 500 first-year students and 34 instructors.

Before the semester began, teaching administrators and mentors from Tech, Communication, and English shared resources and mapped out a few specific ways instructors would be encouraged and expected to connect their courses. Information sessions and workshops were held with potential instructors during Spring 2015. As compensation for the extra work this type of teaching would involve, Fall 2015 English instructors were paid a stipend of $750, and Communication instructors that year were given smaller class sizes.

During Fall 2015, the 40 students in each integrated Design Thinking course were divided equally into 2 groups of 20. One half enrolled together in the required introductory Communication course, and the other in the required introductory English course. Adjustments were made to the usual maximum class size of these Communication courses (usually capped at 25). All students in the Integrated First-Year Experience shared instructors, classroom space, and class time with the same group of peers across 2 paired courses—either Design Thinking and English, or Design Thinking and Communication. Schedules and meeting locations were arranged so that each pair of courses would meet consecutively once per week in one of two brand new technology classrooms. These spaces were designed with ample space for group work, multiple projector screens, whiteboards, laptop carts, and plenty of power outlets for students' electronic devices. This shared classroom space allowed instructors and students from that pair to talk between courses if needed.

It is important to note some significant differences in the overall programmatic structures of each of these courses. A centralized syllabus for Communication courses meant that more consistent and clear connections between Communications and Design Thinking could be planned in

advance and supported by course administrators. In contrast, the high level of diversity and flexibility of English instructors' approaches to their course meant that integration between English and Design Thinking required much more mid-semester adjustment and regular negotiation between instructors. Updates to the program in Years 2 and 3 address this potential imbalance and attempt to engage instructors in earlier planning and preparations as much as possible.

Understandably, the first implementation of the Integrated First-Year Experience did not unfold without conflict. As administrators and researchers expected, mixed levels of engagement from instructors led to a diverse range of classroom experiences for both instructors and students, and highly varied levels of true integration. At the end of Fall 2015, most administrators and instructors seemed to feel that the integration had strong potential but needed to be refined and more carefully supported. The qualitative analysis of feedback from Fall 2015 instructors and students ultimately informed various changes to the program and new forms of training for Fall 2016 Integrated First-Year Experience instructors.

**Year 2: 2016–2017**
Following the preliminary assessments of the 2015–2016 academic year, the IFYE program administrators recognized the importance of clarifying the goals of the program and offering more explicit support for instructors. During its second year, the Integrated First-Year Experience program was again implemented for more than 500 first-year students, but with some logistical and structural modifications. The program's core goals, structure, and overall scope remained, but several small but significant refinements were developed and implemented.

- During year 2, a similar number of integrated sections were offered (12 total), but these were split evenly across Fall and Spring semesters. During Fall 2016, 6 integrated and 6 non-integrated Design Thinking sections were taught by a total of 16 instructors from Tech, Com, and English.

- Sharing classroom space did not ultimately seem as beneficial as the administrators had initially hoped, so this element of the integration was discarded.

- The extra $750 stipend was extended to Communication instructors as well as to English instructors, and integrated Communication courses were kept at the typical size of 25 students each, maximum.

- To incentivize concerted engagement from all instructors, 1/3 of the offered stipend was paid at the start of the term and the other 2/3 at the end of the term, based on satisfactory completion of the program's clarified expectations.

- All instructors, many of them brand new to the integration program, were required to attend a pre-semester meeting and co-teaching workshop together, to meet with the instructors in their trio regularly, and to officially document their collaboration using meeting notes.

During the week before the Fall 2016 semester was to begin, administrators gathered all 16 instructors, explained the motivation for and goals of the First Year Experience program, outlined their concrete expectations for instructors, and supervised introductions and collaborative brainstorming. As part of this meeting, instructors discussed their personal interpretations of the program's goals and shared their teaching priorities and pedagogical values. In groups, instructors also drafted a "contract" in line with the administrators' expectations; these contracts included specific commitments to meet often as a trio and to plan at least 3 specific co-teaching days where 2 or 3 instructors would meet together with all 45 students.

More structure was also added to the final project for all three courses, so as to connect elements of the project together more logically and consistently. In Design Thinking students would work in teams to research, design, and prototype a solution to a global challenge. The culmination of their design work is a persuasive presentation to would-be funders of the solution, which is graded in students' Communications course. Students in English are assigned to complete a companion video about their solution.

Research and data collection continued during this semester, and results so far show more consistency and evenness among instructors' efforts to connect their courses.

**Year 3: 2017–2018**
The refinements introduced during Year 2 are now beginning to stabilize within the program. As in Year 2 of the Integrated First-Year Experience, Year 3 offered 6 integrated sections during Fall 2017 and 5 during Spring 2018. Support and training for instructors was also set up as it had been for 2016–2017, with pre-semester workshops and clearly outlined responsibilities. During Year 3, about half of all instructors were returning to the program. These instructors acted as mentors and examples to new instructors who were inexperienced in teaching an integrated course. English administrators and mentors have developed more shared, set assignments and sequences as part of the program's stabilization, hoping that more structural similarities across English courses will facilitate not only instructors' abilities to create synergy and overlap within their day-to-day pedagogy, but also the likelihood that students will recognize more key shared principles and concepts across both disciplines.

**Research and assessment**
Over the course of these three years, a large team of graduate research assistants have collected various data from students and instructors in order to investigate what difference the course integration makes and whether this type of integration will improve students' learning, academic engagement, and sense of community. This research will not only help us to understand the relative success of the IFYE program, but may also inform future interdisciplinary integration and pedagogical initiatives at our own institution and others. This section briefly describes our research questions, data collection efforts, and analysis methods.

Both qualitative and quantitative data have been collected as part of this mixed-methods assessment study. Some student data in particular were collected as a matter of normal

educational procedure, including student work, course evaluations, attendance, drop rates, and other student surveys. Samples of student writing, presentations, and design projects were also collected from students in integrated and non-integrated Tech, Com, and English sections after the end of all Fall semesters (2015, 2016, 2017). Series of focus groups for students and instructors were conducted over the course of all Fall semesters (2015, 2016, and 2017). Data collected from instructors also included early-semester, mid-semester, and late-semester journal responses and selected course materials—primarily course syllabi and assignment sheets. Some classroom observations were conducted during Fall 2015, but these were limited in scope [23].

Table 2 presents our key research questions and sub-questions, collated with the data collection points meant to inform answers to those questions. The third column summarizes some of our findings so far.

Table 2: Research Questions, Data Collection, and Findings Summarized

| Research Question | Relevant Data | Summary of Findings |
|---|---|---|
| 1a. Do students learn writing skills more effectively in integrated sections than in non-integrated sections? | Existing research writing assignment in English course | Evaluation and analysis of student work is ongoing; samples of research writing from Fall 2016 integrated English sections show lower scores than writing samples from non-integrated English sections when evaluated with a holistic 6-point rubric scale. Analysis of this data continues; publications discussing some of these results are currently under review. |
| | Existing writing assignments in Technology course | |
| 1b. Do students learn communication skills more effectively in integrated sections than in non-integrated sections? | Evaluation of existing presentation assignments in Communications course | Presentations from Fall 2016 integrated Design Thinking sections score significantly higher compared to presentations from students in non-integrated Design Thinking sections [24].

Both instructors and students commented in focus groups that giving presentations was less intimidating and that students felt or seemed more confident. Coding and analyzing recordings will allow us to confirm this. |
| | Evaluation of existing presentation assignment in Technology course | |
| 1c. Do students learn design thinking more effectively in integrated sections than in non-integrated sections? | Existing design assignments in the Technology course | Analysis of students' design portfolio assignments does not reveal significant differences in quality between students' work in integrated Design Thinking sections and non-integrated sections [25]. |
| | Student responses to a decision making strategies survey | |
| 2. Will the integrated courses increase students' perceived learning and sense of self-efficacy? | Student responses to the IMPACT survey of student learning | Analysis of partial survey results has shown that students do not seem to recognize increased learning or engagement [26].

Additional analysis of surveys and focus groups is still underway. |
| | Student focus group interviews | |
| 3. Will the integrated courses help students engage with and value the broader academic community and mission of the University? | Student survey responses | Many instructors reported higher than normal attendance rates and greater participation in class, which could signify increased engagement.

Quantitative data related to this research question is still in process of being analyzed. |
| | Student focus group interviews | |
| | End-of-semester course evaluations | |
| | Student responses to team member effectiveness surveys (CATME) | |

| Research Question | Relevant Data | Summary of Findings |
|---|---|---|
| | Attendance rates | |
| | Drop/fail/withdrawal rates | |
| 4. How and in what ways are English, Communication, and Technology courses being integrated? | Student focus group interviews | Keys to smooth, successful integration are regular communication among instructors and a willingness to be flexible [27]. |
| | Instructor focus group interviews | |

The mixed results we are seeing so far indicate that the Integrated First-Year Experience has had at least some positive affect on students' learning, engagement, and sense of community overall. Student presentation skills have been most positively and most obviously effected by the integration. More analysis is needed to fully understand and evaluate the value and impact of the program.

**Conclusions**
We add this report and research summary to the many other voices advocating for integrated, interdisciplinary pedagogy [3] [5–6] [9] [13–15]. From the implementation of this particular program, and from nearly three years of research on the impacts of the Integrated First-Year Experience, we can offer the following insights and recommendations.

*From student focus group responses*, structural/curricular connections such as a combined final project or overlapping content topics seem to be the clearest evidence to students of the integrated nature of the course. More nuanced, conceptual overlaps (such as the shared need to consider a user/audience whether designing a product or composing a speech or piece of writing) are less immediately obvious to most when they reflect on their learning experience. Some students commented that the Design Thinking/Communication side of the integration felt much more strongly integrated than the Design Thinking/English side. This could be the result of how relatively structured and similar all Communication syllabi have been compared to the more instructor-specific syllabi of English at Purdue University. The efforts to develop more consistent, shared English assignments for all integrated sections will help to address this student perception in future semesters.

*From instructor focus group responses*, regular and open communication among all members of each teaching trio is an important key to successfully and confidently integrating day to day pedagogy and planning connections across curricula. Instructors from different disciplines may need to take time to understand the core principles, priorities, and terminology used by the other instructors they work with. Making such efforts not only contributes to more earnest and meaningful integrated pedagogy, but also may provide instructors (whether graduate instructors or not) with a broader, more flexible interdisciplinary perspective that may serve them well in their professional development beyond this integrated teaching experience.

We will continue developing and refining the Integrated First-Year Experience program this year and in the future, making additional changes based on what we are learning about its impact on students and on instructors. As we continue to analyze data from all three years of this program, and collect and analyze data from future implementations, further insight, more detailed

comparisons, and clearer results will be possible. Our research and documentation of this ambitious Integrated First-Year Experience has so far illuminated which aspects of this endeavor are working most smoothly with the most obvious benefits, and which may need additional refinement and attention before the program can have the most positive and measurable impacts we hope that it will.

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