Assessing the Impact of an Interdisciplinary First-Year Experience Program

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Abstract
This research paper builds upon an ongoing exploration of a large-scale, interdisciplinary course integration for first-year Technology majors. Our research begins to show that the program is making measurable differences to students' learning, engagement, and sense of community. Administrators and instructors from 2 colleges within the university collaborated to organize and teach paired sections of Technology, English, and Communication courses. All 3 classroom instructors in each set of sections work together within the Integrated First-Year Experience, which ultimately aims to tie essential skills and concepts from the humanities and STEM fields to realistic global problems and contexts. The program was implemented for more than 500 first-year students in each academic year (2015–16 and 2016–17). Our research responds to questions about the potential for integrated courses to improve students' conceptual learning and engagement with the university, and about the most effective ways for instructors and administrators to plan, support, and implement this kind of integration. We demonstrate the potential for interdisciplinary pedagogy generally and STEM–Humanities integration in particular to improve students' perceived learning transfer and sense of academic engagement.

Introduction
This research responds to questions about the potential for integrated courses to improve students' conceptual learning and engagement with the university, outlines our methods of evaluating a large-scale course integration, and discusses effective ways for instructors and administrators to plan, support, and implement strong integration. With this paper, we build upon an ongoing exploration of a large-scale, interdisciplinary course integration for first-year Technology majors: the Integrated First-Year Experience. This course integration program grew out of the recognition that Technology students seem to struggle effectively expressing design ideas, while student work in English and Communication courses can sometimes seem to lack a meaningful context outside of the classroom. To address these concerns, and with a goal of enriching the first-year experience for students, administrators and instructors from Purdue's Polytechnic Institute, English Department, and School of Communication all collaborated to organize and teach paired sections of Technology, English, and Communication courses. The resulting Integrated First-Year Experience brings humanities and STEM fields into cooperation, asking instructors from both to collaborate at the classroom level. The program's overall goal has been to improve student learning, transfer, academic engagement, and sense of community.

The following sections of this paper engage with existing literature and provide background on the program and its development since 2015. In order to document and measure the impact of our integrated pedagogy over the last 2 years, we have collected and analyzed student data from both integrated and non-integrated sections of the courses involved. Our analysis and comparisons encompass Fall 2015 and Fall 2016 sections as well as integrated and non-integrated sections from Fall 2016. Following this analysis, we discuss the implications of our findings and plans for future research.

Existing Research on Assessing Integrated Pedagogy

Integration among and across engineering and other disciplines has been studied from many perspectives.[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11] Honey, Pearson, & Schweingruber[11] summarized much of the current integration research and put forth concrete principles of effective integration. Their report also acknowledged the risks and challenges of implementing integrated pedagogy. Others' reports on integration cover various program designs and strategies, and have outlined specific ways of assessing such programs. Kellam et al.[8] described a curricular integration among design, engineering, and social sciences threaded through 4 years of their engineering program, noting that the goal was for disciplines to integrate "at both a content level (integration of content across courses) and a meta-level (integration of meta-learning and ways of thinking)" (p. 2). They implemented a studio requirement each year, where project based learning, community service, and reflection are highlighted. Kellam et al.[8] drew from student reflections and focus group transcripts in their evaluation of this long-term integration. Guthrie et al.[6] used quantitative student self assessment and collected student comments to gauge the effectiveness of their interdisciplinary capstone design course. Rhee et al.[9] in "A Case Study of a Co-instructed Multidisciplinary Senior Capstone Project in Sustainability" discussed a senior capstone course where students engage together with specific shared projects, share classroom space and meeting times. Mentors from several engineering and non-engineering disciplines assist students. Rhee et al.[9] assessed their program using surveys, focus groups, and interviews.

There is strong potential for integrated and interdisciplinary curriculum to improve student learning and experience. Transforming engineering curricula to more thoroughly and consistently integrate core principles of engineering design with communication and critical thinking skills can make engineering education more valuable and more effective overall; however, such integration efforts may not always succeed. Often the work of integration is highly demanding in terms of logistical planning, institutional support, and instructor commitment, as Hirsch et al.[12] recognized. Guthrie et al.[6] noted that collaborative, integrated pedagogy "requires significant time, a flexible mindset and a commitment to collaborate." Combining resources across colleges or schools provides great opportunities for interdisciplinary, cross-college instruction, but also comes with complexities and potential costs. Our project compares the implementation of this integration program across two semesters, documents the pedagogical and programmatic improvements being made, and begins to measure what difference the program has made in terms of students' experiences. We describe specific pedagogical and logistical preparations and our preliminary quantitative assessment of the results.

Background and Research Questions

The Integrated First-Year Experience was implemented for more than 500 first-year students in each academic year (2015-16 and 2016-17). A description of the Integrated First-Year Experience and related assessment is described more fully in Chesley et al.[13] Here we review the general logistics of the program for each year's implementation. During both years, Technology instructors teaching Design were paired with English and Communications instructors to collaboratively connect and reinforce the skills of all three courses for students enrolled in the program. In each introductory Design course, 40-45 students are enrolled; of these, 20-25 are also enrolled together in an introductory Communication course, and 20 are enrolled together in an introductory English composition course. All students enrolled in the Integrated First-Year

Experience shared instructors, classroom space, and class time with the same group of peers across two paired courses—either Design and Composition, or Design and Communication. All three classroom instructors in each set of sections worked together within the Integrated First-Year Experience.

At Purdue University, the introductory Communication course and the introductory English course are required of nearly all students. The introductory Design course is required of every student majoring in the college of Technology at this institution, and students are encouraged to take the course during their first year. For the first implementation of this course integration in Fall 2015, administrators and instructors taught 13 sections of integrated Technology courses and 3 non-integrated sections. In the spring, 1 integrated section was taught along with 9 non-integrated sections. The following academic year, 12 integrated sections were taught, but split across Fall and Spring semesters evenly. Thus, 6 integrated and 6 non-integrated Technology sections were taught during Fall 2016. Data collection for this report is limited to fall terms only because the spring terms' courses included a large number of upper level students who may be enrolled in one, but not all three courses.

To measure the impact of this interdisciplinary integration, our larger research project has collected and will be analyzing qualitative and quantitative data from students, instructors, and administrators involved in the Fall 2015 and the Fall 2016 semesters. For the current study, we wanted to know whether students' perceptions of their own learning and engagement with design thinking were higher in integrated sections of this Technology course. We also hypothesized that the refinements and changes made to the Integrated First-Year Experience would lead to higher perceived learning transfer and engagement. Our basic research questions are:

1. Did changes to our integrated pedagogy improve students' learning experience, sense of engagement and transfer in integrated sections in year 2?
2. Does the integration program lead to a better learning experience and sense of transfer and engagement for students in integrated sections compared to non-integrated sections?

To address these questions, we first describe the Integrated First-Year Experience program as it was implemented in Fall 2015 and then in Fall 2016. We then describe our data collection and analysis thus far.

Year 1: Fall 2015

For this new course integration, 34 instructors from all 3 departments were grouped together in "trios" to teach and integrate their Design Thinking in Technology, English, and Communication courses. Each trio of course sections included one Design Thinking section, one English section, and one Communication section, all linked together by virtue of including the same students and meeting at adjacent times in the same classroom space. Table 1 presents more detail about each course. Table 2 demonstrates the schedules for a typical integrated set of courses. Before the semester began, teaching administrators and mentors from Technology, Communication, and English shared resources and mapped out a few specific ways instructors would be encouraged and expected to connect their courses. As compensation for the extra work this type of teaching involves, Fall 2015 English instructors were paid a stipend of $750, and Communication instructors were given smaller class sizes.

Table 1: Characteristics and meeting details of each integrated introductory course, Fall 2015

	Design course	**English composition course**	**Communication course**
Credit hours	3	4	3
Max. class size	40 students	20 students	20 students
Meetings/week	2	4	3
Meeting spaces	Large technology lab	Traditional classroom, conference room, traditional computer lab, and the technology lab	Traditional classroom and the technology lab
Course structure	Flexible, centralized course-wide syllabus	8 variations on course-wide goals, instructors create individual custom syllabi	Strict, centralized course-wide syllabus

Each course comes with a unique programmatic structure. The relatively set, centralized syllabus for Communication and Technology courses allowed for several specific, pre-planned integration ideas, in terms of class activities, small assignments, and course projects. In contrast, the relative flexibility and higher autonomy of English instructors meant integration between these two courses likely required more mid-semester adjustments and day-to-day work.

Table 2: Sample schedule and meeting arrangements for a typical set of integrated courses, Fall 2015. Shaded blocks indicate which courses shared classroom space on which days.

Meeting days	**Design Thinking section**	**English section**	**Communication section**
Monday	9.30 am, technology lab **40 students**	10.30am, technology lab **20 students**	10.30am, traditional classroom **20 students**
Tuesday	X	10.30am, conference room **10 students**	X
Wednesday	9.30am, technology lab **40 students**	10.30am, traditional classroom **20 students**	10.30am, technology lab **20 students**
Thursday	X	10.30am, computer lab **20 students**	X
Friday	X	10.30am, conference room **10 students**	10.30am, traditional classroom **20 students**

Understandably, the first implementation of the Integrated First-Year Experience during the Fall 2015 semester was not perfect. Mixed levels of engagement from instructors and the mixed responses from both students and instructors were in line with researchers' expectations for this first iteration of the program. Overall, the attitude held by students, instructors, and administrators at the end of Fall 2015 was that the integration had strong potential and needed to be refined. Qualitative data from Fall 2015, including feedback from instructors and students, informed the preparation of instructors for the Fall 2016 iteration of the Integrated First-Year Experience.

Year 2: Fall 2016

The program's core goals, structure, and overall scope remained in place for the following Fall semester, with involvement and preparations done within the same departments for the same 3 courses. Based on observations, group interviews, and survey responses from those involved with the Fall 2015 Integrated First-Year Experience, some logistical and structural modifications were made to the program:

- Sharing classroom space did not ultimately seem as beneficial as program administrators hoped. English classes returned to their typical meeting locations, while Communication instructors continued to meet in the shared space once per week.
- Integrated Communication courses returned to their typical size of 25 students per section. Instead of a majority of Design sections being integrated during Fall semester, only half participated in this program. Of the 12 sections offered, 6 were integrated, with another 6 integrated sections planned for Spring 2017. This more balanced arrangement allows Communication and English instructors to work on this project continuously during the year rather than one semester on and one semester off.
- The $750 stipend was extended to Communication instructors as well as to English instructors. As incentive for all instructors' concerted engagement, 1/3 of the stipend was given at the start of the term and the other 2/3 was given at the end of the term, based on satisfactory completion of the program's clarified expectations.
- All instructors were formally expected to attend an opening preparation and orientation workshop on the goals of the program, which included a presentation on co-teaching.
- Instructors were required to meet with the instructors in their trio regularly, and document their collaboration in some way.

Programmatic and Pedagogical Refinements

Following the preliminary assessment of the program's initial implementation (see Chesley et al.[13]), administrators recognized an opportunity to clarify the goals of the program for instructors, and to offer more explicit support for instructors as they worked to meet those goals. This took the form of a full team meeting and co-teaching workshop before the semester began.

The week before Fall semester began, administrators gathered all 16 instructors, explained the motivation for and goals of the Integrated First Year Experience program, outlined their concrete expectations for instructors, and supervised introductions and collaborative brainstorming. During this meeting, researchers and administrators also introduced our research and the

opportunities instructors and their students would have to participate. After a review of the challenges and insights gained during the previous year, instructors were given the chance to discuss their interpretations of the program's goals, share their previous teaching experience, and discuss 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 as a trio often and to plan at least 3 days of co-teaching where all 3 instructors and all 45 students would meet together at the same time. The first of these joint lessons was to be planned for early in the semester, with most instructors collaboratively introducing the integration to students within the first week of classes.

Data Collection

We collected and analyzed both quantitative and qualitative data about students' and instructors' experiences for both Fall 2015 and Fall 2016 semesters. The current project deals with quantitative student data only. All other data is in the process of being analyzed.

All students in the integrated and non-integrated Design Thinking course were invited to complete a university-administered survey.[14] This set of survey questions, distributed and collected by the university's Center for Instructional Excellence, consists of 6 main constructs measuring student motivation, need for autonomy, perceived relevance of the course, and overall learning experience. For our study, we wanted to measure successful student learning and engagement. The integration between Technology, English, and Communication courses specifically aimed to not only increase student learning in all three areas, but also to improve students' sense of each course's relevance and transferability.

For the purposes of this portion of our research, we have focused on end-of-semester responses to two sections of the overall survey:

1. The **Perceived Knowledge Transfer Scale** or PKTS (see Appendix A), which measures perceptions of a course's relevance and transferability on a 7-point Likert scale.[15]

2. The **Learning Climate Questionnaire** or LCQ (see Appendix B), which measures students' perceptions of learning autonomy in the classroom on a 7-point Likert scale.[16, 17]

The Perceived Knowledge Transfer construct asks students how clearly or strongly they connect the content of the course to learning experiences in other courses, and/or to their future academic and professional goals. The questions about Learning Climate focus on students' interactions with instructors and how well they felt their learning was prioritized/supported in the course. Higher student ratings on the Perceived Knowledge Transfer Scale will show evidence of instructors' efforts to highlight cross-disciplinary connections within the course. Higher ratings on the Learning Climate Questionnaire will indicate a productive, positive, active and fair learning environment. If integrated sections score relatively high in both constructs compared to non-integrated sections, we can conclude that the goals of the course integration are being met, in terms of students' perceptions.

Analysis

Our research team received the Fall 2015 and Fall 2016 results of this survey with all individually identifying data removed and responses sorted according to course registration number. We calculated Perceived Knowledge Transfer Scale and Learning Climate Questionnaire scores for each semester's integrated sections of Design Thinking, and the same scores for all non-integrated Fall 2016 sections. The calculation utilized was the individual student average response to questions of Perceived Knowledge Transfer and the Learning Climate.

For Fall 2015, statistical analysis revealed a great amount of variation in scores. Across 13 integrated sections, mean Learning Climate scores ranged from 3.45 up to 6.08 (on a 7-point scale) and mean Perceived Knowledge Transfer scores ranged from 2.64 to 5.49 (on a 7-point scale). Neither measure was normally distributed. The deviation from normality and the wide variation made comparison between integrated and non-integrated sections difficult and complicated our assessment of the program. Future research will combine these Fall 2015 survey responses with additional qualitative data from that semester, and further explore the differences among all integrated sections and their companion courses in English and Communication.

Given non-normally distributed data among Fall 2015 data and Fall 2016 data, a Mann-Whitney *U* test was conducted. The Mann-Whitney *U* test is utilized for nonparametric data which is comparable to the independent samples *t*-test.

Fall 2015 to Fall 2016 Comparison

The median score reported by students in Fall 2015 integrated sections was 5.50 for Learning Climate and 4.50 for Perceived Knowledge Transfer, while Fall 2016 integrated sections reported median scores of 5.00 and 4.50 respectively. A Mann- Whitney *U* test showed that there was no statistically significant change in student perceived Learning Climate from Fall 2015 to Fall 2016 integrated sections, $U = 18479.000$, $p = .089$. Student Perceived Knowledge Transfer was also not statistically significant between Fall 2015 and Fall 2016, $U = 19599.000$, $p = .866$.

Table 3: Median scores for Learning Climate

	Median student reported scores		
	Fall 2015 integrated sections (n=307)	Fall 2016 integrated sections (n=134)	p-value
Learning Climate	5.5	5.0	.089

Table 4: Median scores for Perceived Knowledge Transfer

	Median student reported scores		
	Fall 2015 integrated sections (n=300)	Fall 2016 integrated sections (n=132)	p-value
Perceived Knowledge Transfer	4.5	4.5	.866

Fall 2016 Integrated to Non-Integrated Comparison

The median score reported by students in Fall 2016 non-integrated sections was 5.33 for Learning Climate and 4.63 for Perceived Knowledge Transfer, while Fall 2016 integrated sections reported median scores of 5.00 and 4.50 respectively. A Mann-Whitney U test showed that there was no statistically significant change in student perceived Learning Climate from integrated to non-integrated sections, U= 7419.500, p= .535. Student Perceived Knowledge Transfer was also not statistically significant between integrated and non-integrated, U= 7053.500, p= .617.

Table 5: Median scores for Learning Climate: Integrated/Non-integrated Comparison

	Median student reported scores		
	Integrated sections (n=134)	Non-integrated sections (n=116)	p-value
Learning Climate	5.00	5.33	0.535

Table 6: Median scores Perceived Knowledge Transfer: Integrated/Non-integrated Comparison

	Median student reported scores		
	Integrated sections (n=132)	Non-integrated sections (n=111)	p-value
Perceived Knowledge Transfer	4.50	4.63	0.617

Discussion

These results show that, according to these measures, the Integrated First-Year Experience has not significantly improved learning climate or perceived sense of this course's relevance, nor has the refined approach of Fall 2016 made a difference in terms of students' perceptions in these areas. More analysis is needed to fully understand and evaluate the value and impact of the integration program. Students' self-assessment of their learning experience and engagement with course material may not match the learning and transfer that happen in reality. Direct analysis of student work from these courses is underway and should provide additional insight into whether this was the case. We also speculate that some benefits of this program may be delayed and not measureable in the last few weeks of the course. Despite their responses on these two survey constructs, students may be internalizing and transferring skills and knowledge from these courses in ways they do not consciously recognize. In addition, it is possible that these survey instruments are not aligned closely enough with the particular goals of the program to measure the intended differences its administrators hope to make.

We plan to continue developing and refining the Integrated First-Year Experience program, taking into account what we are learning about its impact on students and on instructors. Our next step in this ongoing assessment research is to analyze and compare design assignments, composition assignments, and oral presentation assignments collected from students in integrated Design Thinking courses and from students in non-integrated courses. We hope that our qualitative analysis will illuminate a fuller picture of this program and its potential for leveraging interdisciplinary STEM–Humanities connections in order to improve students' preparation for the grand challenges of the world.

References

1. Al-Holou, N., Bilgutay, N. M., Corleto, C., et al. (1999). First-Year Integrated Curricula: Design Alternatives and Examples. JEE 88.4 435-448.
2. Paretti, M. (2008). Teaching Communication in Capstone Design: The Role of the Instructor in Situated Learning. Journal of Engineering Education 97(4), 491-503.

3. Bannerot, R., Kastor, R., & Ruchhoeft, P. (2010). Multidisciplinary Capstone Design at the University of Houston. Advances in Engineering Education 2(1), 1–33.
4. Enke, K. A. E. (2011). Lasting Connections: A Case Study of Relationships Formed During a First-Year Seminar Course. Journal of The First-Year Experience & Students in Transition, 23(1), 75-102.
5. Smith, R. (2011). Learning Community Transitions in the First Year: A Case Study of Academic and Social Network Change. Journal of The First-Year Experience & Students in Transition, 23(2), 13–31.
6. Guthrie, J. B., & Estes, A. C., & Nelson, J., & Nuttall, B. (2012, June), Interdisciplinary Capstone Design: Architects, Structural Engineers, and Construction Managers Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. https://peer.asee.org/20764
7. Gardner, A. F. (2013). Predicting Community College Student Success by Participation in a First-Year Experience Course. (Unpublished dissertation). Western Carolina University, Cullowhee, NC.
8. Kellam, N., Walther, J., Costantino, T., Dodd L., & Cramond, B. (2013). Integrating the Engineering Curriculum through the Synthesis and Design Studio. Advances in Engineering Education Winter 2013, 1–33.
9. Rhee, J., Oyamot, C., Parent, D., Speer, L., Basu, A., & Gerston, L. (2014). A Case Study of a Co-instructed Multidisciplinary Senior Capstone Project in Sustainability. Advances in Engineering Education Summer 2014, 1–29.
10. Brizee, A., & Langmead, J. (2014, June 14). Cross-disciplinary collaboration: Fostering professional communication skills in a graduate accounting certificate program. *Across the Disciplines: A Journal of Language, Learning, and Academic Writing*, 11(1). Retrieved from http://wac.colostate.edu/atd/articles/brizee_langmead2014.cfm
11. Honey, M., Pearson G., & Schweingruber, H. (Eds.). (2014). STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research. Washington, DC: The National Academies Press.
12. Hirsch, P.L., Schwom, B.L., Yarnoff, C., Anderson, J.C., Kelso, D.M., Olson, G.B., and Colgate, J.E., "Engineering Design and Communication: The Case for Interdisciplinary Communication," International Journal of Engineering Education, Vol. 17, Nos. 4 and 5, 2001, pp. 343–348.
13. Chesley, A., Mentzer, N., Jackson, A., Laux, D., & Renner, M. (2016, June). Integrating Technology, English, and Communication Courses for First-Year Technology Students. Paper presented at the *ASEE Annual Conference & Exposition*, New Orleans, LA. https://peer.asee.org/25414
14. Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self- determination of behavior. Psychological Inquiry, 11, 227-268.
15. Richards, K. A. R., Zissimopoulos, A., & Levesque-Bristol, C. (2014). *Students' perceptions of the value of college courses: Creation and validation of the Perceived Knowledge Transfer Scale*. Center for Instructional Excellence. Purdue University.
16. Black, A. & Deci, E. (2000). "The Effects of Instructors' Autonomy Support and Students' Autonomous Motivation on Learning Organic Chemistry: A Self-Determination Theory Perspective." *Science Education*, 84: 740–756. doi:10.1002/1098-237X(200011)84:6<740::AID-SCE4>3.0.CO;2-3

17. Williams, G. C., & Deci, E. L. (1996). “Internalization of biopsychosocial values by medical students: A test of self-determination theory.” *Journal Of Personality And Social Psychology*, 70(4), 767-779. doi:10.1037/0022-3514.70.4.767