

Education Redesigned: Impacting Teaching and Learning through a Faculty Development Course Redesign Program

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Introduction

Many engineering colleges are implementing First-Year Engineering (FYE) programs which have a common first year curriculum (e.g., Calculus, Physics) required for new engineering students before they transition to their desired major (e.g., civil engineering, mechanical engineering, aerospace engineering). FYE programs serve thousands of students a year including new students and students transferring from other institutions or another academic discipline into engineering. The FYE program helps these students develop a common knowledge base and skill set needed to progress and persist through their desired engineering degree program.

At an institutional level, many universities are prioritizing active learning and student success, but few are doing so at the broad campus-wide scale necessary to affect any sort of culture change. Rarely do universities, especially research intensive universities, attempt large-scale, sustained faculty development efforts to systematically improve the quality of undergraduate education, especially with instructors who have not received much support in teaching prior to their first teaching experience¹.

The IMPACT program, “Instruction Matters: Purdue Academic Course Transformation” (impact.purdue.edu), stands out as one exception and was recognized nationally by the Chronicle of Higher Education as a program that changes classroom culture². IMPACT is a faculty learning community (FLC) that is informed by research-based practices in teaching and learning as well as the motivational principles of self-determination theory (SDT)^{3,4}. Instructors view IMPACT as a valuable source of professional development that positively impacts both student learning outcomes and their own teaching practice. Instructors participating in IMPACT report a significant increase in satisfaction with their teaching as well as an increase in student engagement.

Students enrolled in a course that has gone through IMPACT report high levels of perceived competence, ability to transfer knowledge to other relevant courses and experiences, and higher learning gains. Furthermore, student-centered learning environments are associated with positive outcomes, especially for students with lower levels of academic achievement, reducing the achievement gaps for underprepared students.

In this paper, an overview of the IMPACT program will be presented. The curriculum of the FLC and discussion of the theoretical framework will be discussed. Evidence is given of IMPACT’s success as a faculty development and course transformation program since it started in the summer of 2011. Specific evidence will be discussed regarding the program’s positive influence on instructors’ teaching practices as well as student success and learning gains in STEM courses.

Overview of the IMPACT program

The IMPACT program originally built upon the work of Carol Twigg and the National Center for Academic Transformation (NCAT). Twigg and NCAT created a tightly structured program by synthesizing research on active learning⁵. NCAT targeted large, introductory, lecture-based courses that had a high rate of D and F grades or student withdrawals (i.e., DFW). The NCAT course design program specifically focused on the use of technology as a means for reducing DFW rates and increasing student engagement. However, the program only allowed instructors a limited number of course redesign models to follow.

IMPACT, like NCAT, initially targeted large, introductory, lecture-based courses with high DFW rates. IMPACT no longer requires courses to meet these criteria but still focuses on undergraduate courses. IMPACT has incorporated SDT, a theory of motivation, into the core structure and practices of the program. SDT provides a theoretical framework that allows participants to choose the specific aspects of their course redesign as well as helps to guide the methodology and assessment measures for gauging student-centered learning.

Participation in IMPACT is now open to any interested part-time, full-time, and clinical faculty responsible for an undergraduate course that they could teach for three iterations. This change in practice resulted in a more diverse set of courses that varies by enrollment size, prior academic performance, and typical student enrollment, all of which help cultivate a desired culture change valuing teaching and learning.

IMPACT is a cohort-based faculty development program that promotes student-centered learning environments through course transformation³. Instructors participating in the program are empowered to design courses that foster student-centered learning through active and collaborative learning, other student-centered teaching and learning practices, and technologies. The commitment to active learning builds upon scholarship from Richard Felder and others that emphasizes critical thinking, group work, and formative assessment as the desired endpoint for all instructors⁶.

The IMPACT program launched in the summer of 2011 with the support of six institutional units: the President's Office, Provost's Office, Center for Instructional Excellence (CIE), Teaching and Learning Technologies (TLT), Institutional Research, Assessment and Effectiveness (OIRAE), and Evaluation and Learning Research Center (ELRC). Libraries personnel joined CIE and TLT in the spring of 2012 as partnering units responsible for implementing the IMPACT program. This partnership recognized that student-centered learning incorporates complex engagements with information⁷.

The overarching goals of IMPACT are to:

1. Refocus the campus culture on student-centered pedagogy and student success
2. Increase student engagement, competence, and learning gains
3. Focus course transformation on effective research-based pedagogies
4. Reflect, assess, and share IMPACT results to benefit future courses, students, and institutional culture

The IMPACT program has been demonstrably effective in improving attainment of course-specific learning outcomes and improved degree completion, persistence, and graduation rates⁸. A recent external review of the program stated, "[IMPACT] is a textbook illustration of how to successfully deliver timely, substantive, high-quality professional-development experiences..."⁸ The program was also recognized as the Chronicle of Higher Education's "2018 Innovator: Six Programs to Change Classroom Culture"².

From IMPACT's launch in the summer of 2011 to the fall of 2018:

- 348 instructors have participated in the FLC, representing every college at the institution
- 78% of IMPACT instructors are from STEM disciplines
- 325 courses have been transformed through IMPACT
- 254 courses have been transformed by instructors after completing IMPACT

Curriculum of IMPACT FLC

The curriculum of the IMPACT program is facilitated by representatives from the three partnering units of CIE, TLT, and Libraries. The facilitators coordinate and deliver a streamlined backward design curriculum focused on motivating learners, learning outcomes, evidence of learning through assessment, and course alignment as well as instructors becoming reflective practitioners^{9, 10}. Each instructor works throughout the semester with a dedicated support team of two or three representatives comprised of the three partnering units.

The curriculum for the IMPACT program is structured as a faculty learning community over the course of 13 sessions (i.e., weeks) lasting 75 minutes³. The 13 sessions are organized into five broad units with specific topics. Each topic is associated with a guiding question for instructors to consider as they redesign their courses. The specific questions are discussed in more detail in a *Change* article¹¹. Instructors are required to produce three main deliverables associated with their course transformations: a redesign goal, learning outcomes, and a course redesign plan (Table 1). There is a monetary incentive attached to each deliverable.

Session	Unit	Topics	Deliverables
1		Welcome to IMPACT	
2	Motivating Learners	Student Characteristics	Learning Outcomes (Initial)
3		Motivational Theories	Redesign Goal (Initial)
4	Learning Outcomes	Outcomes and Objectives	
5	Assessment	Student Performance I	Learning Outcomes (Revised)

6	Assessment	Student Performance II	Learning Objectives
7	Learning Activities	Learning Activities I	
8		Learning Activities II	Course Design Plan (Initial)
9		Connecting the Dots	
10	Drawing It All Together	Redesign Decisions	Redesign Goal (Revised)
11		Redesign Presentations	Course Design Plan (Revised)
12		Reflective Practitioner	
13		Closing the Loop	

Table 1. General IMPACT syllabus with schedule, topics, and deliverables

The first unit, "Motivating Learners," highlights student characteristics as the first topic to set the stage for having instructors think about their classes through the experience of their students, focusing on student learning rather than instructors teaching. Instructors are asked to think about and discuss questions such as "Who are the students taking my course?" and "Why are students taking this course?" These are particularly important questions for instructors of STEM courses because of concerns of a high-rate of DFWs, underrepresented minorities, and persistence to graduation¹².

The second unit, "Learning Outcomes," begins the process of instructors investigating their course more intentionally through the lens of Bloom's Taxonomy and thinking more deliberately about what they want their students to know, do, and value¹⁰. Additional criteria need to be considered as courses within engineering disciplines have ABET programmatic learning outcomes associated with them for accreditation, which might or might not align with specific course-level outcomes. Common challenges for instructors are figuring out the wording of their own learning outcomes instead of just copying the ABET outcomes and being able to articulate how the learning outcomes align with ABET. Instructors, through IMPACT, are able to intentionally redesign their courses starting with the learning outcomes and work on the ABET alignment with their support teams throughout the FLC.

For example, a civil engineering instructor wants students to be able to solve traffic flow problems but also indicates the course is supposed to meet the ABET Student Outcome of "an ability to identify, formulate, and solve engineering problems." In this case, the IMPACT support team worked with the instructor until they formulated a single learning outcome combining the two desired outcomes: "By the end of the semester, students will be able to evaluate traffic patterns and propose remediation solutions." By going through IMPACT, the instructor has

developed more specific and measurable learning outcomes in which they are now able to articulate how they align with the ABET outcomes (i.e., identifying, formulating, and solving are steps in a process for students to evaluate and propose solutions).

The third unit, "Assessment," has instructors focusing on the assessment of and for student learning represented in the learning outcomes and objectives generated in the previous unit. This unit can be challenging for STEM instructors, particularly those who have developed learning outcomes for their redesigned course that are higher-order thinking skills than the original course (e.g., create or analyze versus identify or remember). Continuing with the previous example, the transportation instructor now has to consider how to assess students learning authentically. Do their traditional exams and homework assignments assess this new learning outcome? Or do they need to think of more authentic and appropriate assessments? In this example, the instructor keeps the weekly homework assignments as "concept checks" but then develops projects for students assessing the higher-order learning outcomes.

In the fourth unit, "Learning Activities," instructors discuss and explore learning activities that foster more student-centered learning environments. While the previous unit might be a challenge for some STEM instructors, this unit is the most challenging for all STEM instructors. Instructors struggle with activities that are authentic for student learning within engineering and STEM courses. It could be logistically restrictive, for example, to have a course in a construction management class visit a construction site for an authentic learning activity. In the transportation instructor's example, they actually decide that authentic learning overcomes the logistical barriers. At the beginning of the semester, the instructor gives students a choice between three or four "traffic problems" around the campus community within physical travel distance. The instructor forms teams—considering another ABET student outcome—and throughout the semester students go out to the "project sites" to gather data. Then work on their projects in class while the instructor covers transportation engineering content.

The final unit, "Drawing It All Together," helps instructors revise, refine, and prepare to implement their intended redesigned course. Instructors have time throughout the semester to reflect on course goals and desired student skills. During this time, many instructors identify misalignment between their stated learning outcomes and actual in-class assessments. As an example, an instructor prioritizes students analyzing an electrical current through a complex circuit board but only assesses if the students can identify the different parts of the circuit. Concluding the transportation example, throughout IMPACT, the instructor is able to develop specific, measurable learning outcomes that align with appropriate assessments and are supported with authentic learning activities. A more detailed description of the IMPACT program, the faculty learning community curriculum, and the assessment of IMPACT's effectiveness can be found in the National Institute for Learning Outcomes Assessment's (NILOA) occasional paper¹³.

Theoretical framework for IMPACT

A motivational theory, specifically SDT, provides the theoretical framework informing the structure and implementation of the IMPACT curriculum as well as guides the methodology and assessment measures operationalizing student-centered learning within classroom learning environments. SDT is a humanistic theory of motivation comprised of six mini theories related to development and growth in covering different aspects of motivation and psychological integration. The cornerstone of the specific theory implemented in IMPACT focuses on three basic psychological needs that all individuals have: autonomy, competence, and relatedness, as meeting these needs is the key to increasing students' self-determined motivation and improving academic performance⁴. Satisfying the three basic psychological needs fosters optimal psychological growth, development, well-being, and learning. This theoretical framework and connection to IMPACT as a faculty development program is described in more detail in the NILOA occasional paper¹³.

IMPACT's emphasis on meeting the basic psychological needs of both instructors and students encourages instructors to think critically and act intentionally in order to enhance student learning aligned with the intended outcomes of the course. IMPACT's focus is on supporting instructor autonomy, precisely what many faculty fear they must give up while participating in a course redesign effort.

Autonomy

SDT holds that autonomy does not equate to independence but rather feelings of volition and choice within boundaries. Autonomy represents the need to self-regulate one's experiences and actions. Specifically, instructors and students tend to feel autonomous when they have choices and options about how to perform or present their work. For example, engineering instructors can foster autonomy in their courses by giving a couple of options for a semester project instead of just one. The potential projects give students the perception of choice instead of dictating one project option. In instances where choices are not possible, providing a rationale for tasks that are necessary, but perhaps less interesting or not perceived as inherently valuable, contributes to the satisfaction of the need for autonomy. Instructors who integrate greater levels of autonomy in their courses pay attention to the students' perspectives.

As part of IMPACT, instructors are asked to prepare for sessions by reading curated literature while considering the potential influence to their particular discipline and class. This approach models and aids the incorporation of the critical thinking skills so many instructors wished their students would exhibit. Faculty, during IMPACT, are provided with choices and options in selecting redesign elements; they are not told what to do, but they are guided in making their own course redesign decisions. Modeling the types of student engagement that accompanies a collaborative classroom environment, this approach spurs greater participation during the FLC. This approach also provides a renewed emphasis on student engagement, student-centered learning, and a further de-prioritization of DFW rates.

Competence

Competence has been the focus of multiple higher education studies and refers to our basic need to feel effectance and mastery^{15,16}. The need for competence is satisfied when opportunities to demonstrate one's skills are frequently provided and in a way that allows students to receive feedback and improve on their performance. For example, working in groups or project teams is common in some STEM disciplines and is also a common complaint and/or concern among instructors. An issue here could be that students do not feel competent about working with others, and a process to develop this competence is not in place. Scaffolding of learning experiences tends to foster competence, which also applies to working in groups or teams. In the FLC, faculty work with groups of support team members, modeling group and team work drawing on their expertise.

Relatedness

Instructors foster relatedness through promoting students' feelings of connectedness, intellectually and emotionally, with other students in the class, as well as with the instructor. The need for relatedness is met when students are provided opportunities to interact with each other and the instructor in meaningful ways. This does not mean that students must feel close to everyone in class, but it does mean that students need to feel they can trust the instructor to help them achieve their academic goals in a mutually beneficial partnership. In addition, connection to the material presented in class, also termed relevance, is important to foster student's perceptions of relatedness¹⁷. Taking a previous example, giving students a couple of choices on a semester project fosters efficacy in their learning, but it also allows them to relate or connect to the chosen project fostering motivation. Using a faculty learning community model for the IMPACT program fosters relatedness among instructors and across the entire team of instructors and support team members.

Integrating SDT and IMPACT

The integration of SDT changes the emphasis and philosophy of IMPACT from a course redesign program to a professional development program that focuses on the faculty first and not the course first. Through professional development, instructors are prepared to apply teaching and learning principles in new contexts and situations. This shift also encourages instructors to apply the skills they acquire during the FLC to other courses they are also teaching, generating transformations in courses after completing the IMPACT FLC (i.e., "influenced" courses). Thus, IMPACT fosters faculty development and course transformation rather than course redesign.

By supporting instructors' basic psychological needs of autonomy, competence, and relatedness, instructors are better prepared to discuss teaching and learning, modify their pedagogical practices, and transfer their knowledge and insights learned in IMPACT to new situations. These changes in instructors from across the institution can spark the beginning of a broader teaching and learning culture change. Satisfying the three basic psychological needs helps foster faculty development and understanding of their work with students. The measure of the basic psychological needs in students is discussed in the following section.

Evaluating the influence of IMPACT on STEM

The IMPACT program is evaluated on multiple levels via a collaboration between the Office of Institutional Research, Assessment and Effectiveness (OIRAE), the Center for Instructional Excellence (CIE), and the Evaluation and Learning Research Center (ELRC). OIRAE collects institutional data tracking all instructors and courses that complete the program. Each semester, OIRAE contacts each instructor to determine which course sections should continue to be counted as IMPACT (i.e. transformed) courses. The ELRC collects program evaluation data from faculty via surveys sent out to all instructors pre and post-IMPACT, as well as after the instructors have implemented their redesigned courses. In addition, the ELRC conducts focus groups at the end of each semester for the continuous improvement of the program. Finally, the CIE collects student perceptions survey data from all students enrolled in a course that has gone through the program.

Faculty development

In order to assess changes in instructor perceptions from participating in the IMPACT program, instructors completed surveys prior to beginning the program, upon completion of the program, and after teaching the redesigned course for the first time. These surveys included measures of instructor self-assessment of knowledge and skills, instructor assessment of student behavior and outcomes, and instructor attitudes and beliefs regarding their experiences with teaching and learning (see Figures 1 and 2 for some example questions).

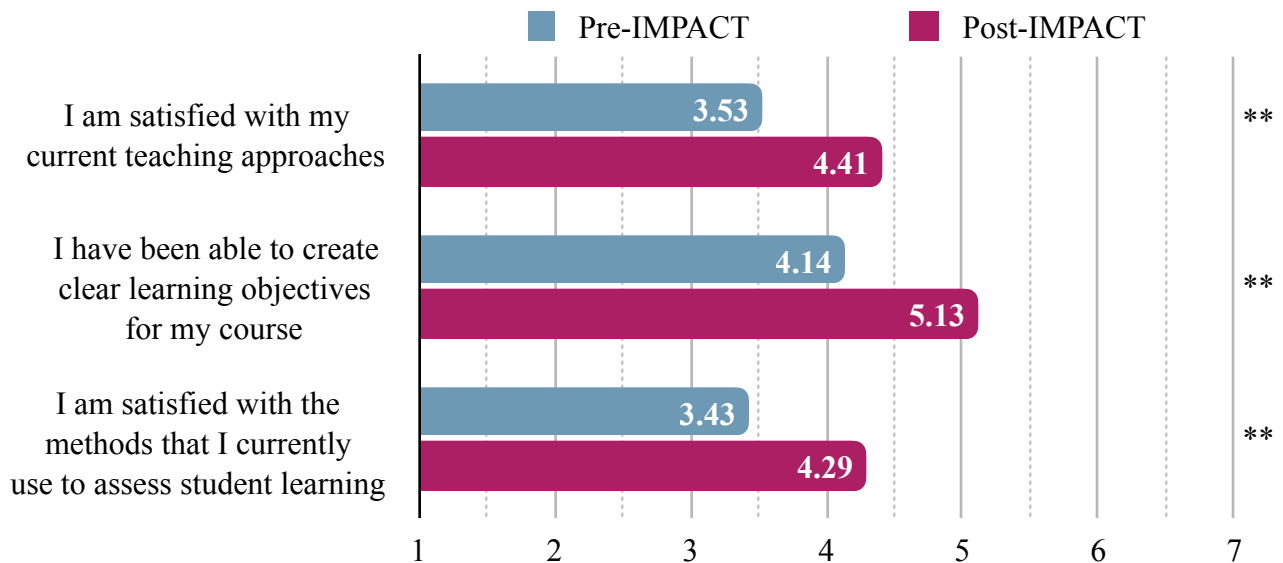


Figure 1. IMPACT fellows' pre-/post-perceptions of their teaching (** $p < .001$)

Paired t-tests were used to measure the changes in instructor ratings when comparing pre-IMPACT participation to post-implementation the redesigned course. Due to the paired analysis method, only instructors who completed each item at both time points were included in the data set. Instructors expressed significantly higher levels of satisfaction in their teaching after

implementing their redesigned course in regards to current teaching approaches ($t(90) = -7.60, p < .001$), appropriate assessment methods ($t(90) = -6.48, p < .001$), and clear learning objectives ($t(90) = -8.74, p < .001$). Participation in IMPACT also indicates significantly enhanced instructors' perceptions that students are active ($t(91) = -4.88, p < .001$), engaged ($t(79) = -4.45, p < .001$), and demonstrating critical thinking skills in the course ($t(87) = -5.37, p < .001$).

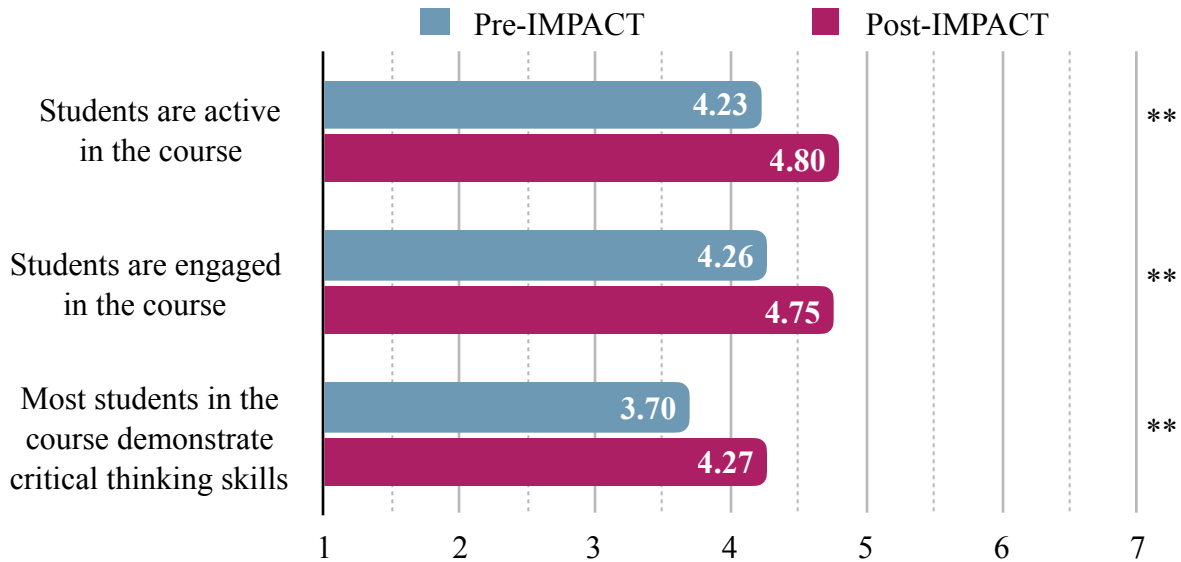


Figure 2. IMPACT fellows' pre-/post-perceptions of their students' learning (** $p < .001$)

When describing their experiences during post-IMPACT focus groups, instructors report investing significant time reflecting and redesigning their course. Overwhelmingly, instructors mention the interactions with other instructors and/or IMPACT facilitators as the single most important aspect of their IMPACT experiences¹⁷. Instructors also highlight the importance of freedom and flexibility to transform their courses based on what they thought was best.

Student perceptions

In addition to instructor-reported data, IMPACT also collects student perceptions data to assess the influence of the program on student perceptions of the learning environment and motivation. As the IMPACT program uses a SDT framework, the student perceptions survey contains measures of learning climate, satisfaction of the basic psychological needs, motivation, and perceived knowledge transfer¹⁸⁻²¹. All measures use a 7-point Likert scale ranging from strongly disagree to strongly agree. Each semester, students enrolled in a course that has been transformed through the IMPACT program receives the perceptions survey during weeks 12-13. Participation in the student survey is optional, although some instructors provide a few extra credit points as a small incentive for participation. The following survey questions are adapted from validated scales of SDT.

About the learning experience (i.e., learning climate)¹⁸

- I feel that my instructors provided me choices and options.
- I felt understood by my instructors.
- My instructors conveyed confidence in my ability to do well in the course.
- My instructors encouraged me to ask questions.
- My instructors listened to how I would like to do things.
- My instructors tried to understand how I see things before suggesting a new way to do things.

Student's overall experience (i.e., short-scale of basic psychological needs)^{19,20}

- I felt like I could make a lot of inputs in deciding how my coursework got done. (Autonomy)
- I was free to express my ideas and opinions in my courses. (Autonomy)
- My feelings were taken into consideration in my courses. (Autonomy)
- People in my courses told me I was good at what I did. (Competence)
- I was able to learn interesting new skills in my courses. (Competence)
- Most days I felt a sense of accomplishment from my courses. (Competence)
- I got along with people in my courses. (Relatedness)
- I really liked the people in my courses. (Relatedness)
- People in my courses were pretty friendly towards me. (Relatedness)

Relevance of the learning experience (i.e., perceived knowledge transfer)²¹

- I felt confident in my ability to apply the course materials in other classes that I had.
- I felt confident in my ability to apply the course materials in my professional life.
- I felt as if the material covered in my courses were relevant to my future career.
- Given the future career that I have chosen, it is important for me to learn the information covered in my courses.
- I understand how I will use the information learned in my courses in my professional life.
- Information learned in my courses will inform my future learning experiences.
- I believe that it is important for me to learn the information included in this course.
- The information learned in this course will help me become a more well-rounded individual.

Results from three semesters of data show that students in engineering courses which have gone through IMPACT (N = 979) report that these courses have highly student-centered learning environments (M = 5.60, SD = 1.16), which are positively correlated with perceived competence, autonomy, and relatedness, as well as self-determined motivation and perceived knowledge transfer (Table 2).

	Motivation	Learning Climate Scale	Basic Psychological Needs			Perceived Knowledge Transfer
			Autonomy	Competence	Relatedness	
Motivation	1.0					
Learning Climate Scale	.533**	1.0				
Autonomy	.380**	.630**	1.0			
Competence	.501**	.596**	.786**	1.0		
Relatedness	.292**	.466**	.714**	.720**	1.0	
Perceived Knowledge Transfer	.620**	.571**	.607**	.661**	.526**	1.0

Table 2. Correlation of student-centered learning variables in engineering courses (** p<.001)

In addition, the relationship between the basic psychological needs of autonomy, competence, and relatedness are also positive and significant as well as all positively associated with self-determined motivation as predicted by SDT¹³.

Student academic success

An initial goal of IMPACT was to increase student academic success and decrease time to degree by transforming traditionally difficult courses. Each academic year, OIRAE examines these metrics for courses with high failure rates (defined as pre-IMPACT DFW rates of 20% or higher), large enrollment (exceeding 100 students), or foundational content (course number of 2xx or below).

The student learning data gathered for many IMPACT courses shows an improvement in the mean final grade and/or a reduction in the DFW rate. Specific evidence can be seen in three undergraduate STEM courses, redesigned through the IMPACT program: Calculus, Chemistry, and Dynamics. Prior to IMPACT, all three courses were traditional, lecture-style courses with little or almost no interaction between the instructor and students. Historically, these courses had DFW rates of 60% (Calculus), 40% (Chemistry), and 30% (Dynamics). The courses were redesigned independently of each other but focused similarly on increasing student engagement.

- Chemistry implemented a classroom response system, demonstrations, and think-pair-share during the class meeting time²².
- Dynamics implemented a course lecture book that students filled in during class and developed a course website for homework solution videos and student discussion²³.
- Calculus reimaged class into group work of three to four students, a “mini-lecture” in the middle of class, and support by three teaching assistants and three peer tutors²⁴.

After going through IMPACT and implementing the redesign, these courses have experienced a marked improvement in student success after being redesigned in IMPACT. All three courses have reduced DFW rates by 20-30% through strategies specific to their context and needs²²⁻²⁴.

Student learning outcomes

In addition, students’ perceived learning gains are assessed as an aspect of IMPACT. The learning outcomes that instructors create during the IMPACT FLC appear as additional questions on the end-of-semester course evaluations. When students perceive the learning environments as student centered, they report significantly greater attainment of the learning outcomes (M = 3.85) as compared to when the learning environment is perceived to be low in student centeredness (M = 2.85)¹¹.

The emphasis on developing clear, articulated, and measurable learning outcomes as part of IMPACT results in an overall reduction of course-level learning outcomes from an average of over five before IMPACT to three or four after. The Cognitive Process Dimension represents a continuum of increasing cognitive complexity from lower order thinking skills (i.e., Remember, Understand) to higher order thinking skills (e.g., Evaluate, Create)^{13,25}. Furthermore, as seen in Figure 3, an initial qualitative study coding learning outcomes, using Bloom’s (revised) Taxonomy, reveals that new outcomes developed during IMPACT feature more specific and measurable wording and are focused more frequently on higher order thinking skills along the cognitive process dimension (n=518).

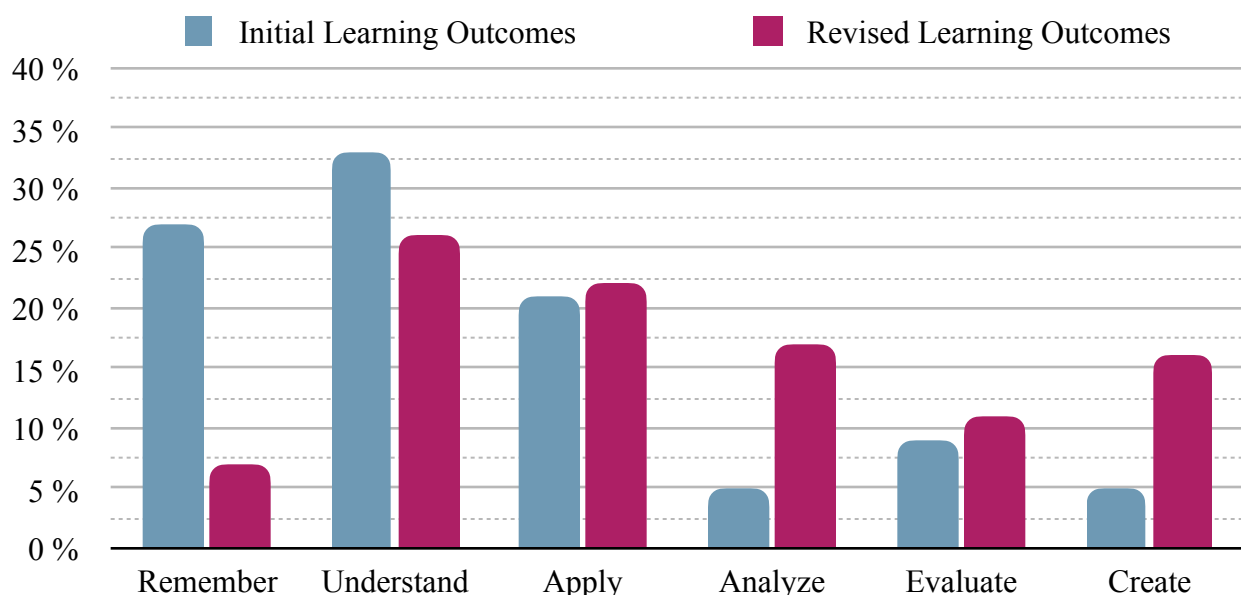


Figure 3. Percent of total IMPACT courses' learning outcomes (n=518)

As a result of IMPACT, instructors articulate learning outcomes farther along the cognitive process domain (i.e., higher order thinking skills)—using a revised version of Bloom's Taxonomy to code course-level learning outcomes²⁶. The average level of cognitive complexity increased during all semesters measured between the spring of 2015 and the fall of 2017^{13,25}. While Understand was still the largest focus of initial or revised learning outcomes for IMPACT courses, a shift toward higher-order thinking skills can be seen (Figure 4). Specifically, a marked de-emphasis on Remember can be seen for student learning, with a 20% decrease between initial and revised learning outcomes. While at the same time, a marked emphasis on Analyze and Create for student learning can be seen with an increase of 12% and 11%, respectively.

Overall, initial learning outcomes for instructors concentrated on lower order thinking with 30% of all learning outcomes focusing on Remember and Understand; compared to 17% of revised outcomes (Figure 4). Revised learning outcomes, however, concentrate on more higher order thinking skills with 14% of all learning outcomes focusing on Analyze and Create; compared to 7% of initial outcomes. There was only a slight change between the initial and revised learning outcome of Apply from 21% to 22%, respectively. However, there was a large change between the initial and revised learning outcome of Analyze from 5% to 17%. A comparison between lower- and higher-order thinking skills can be seen in Figure 4.

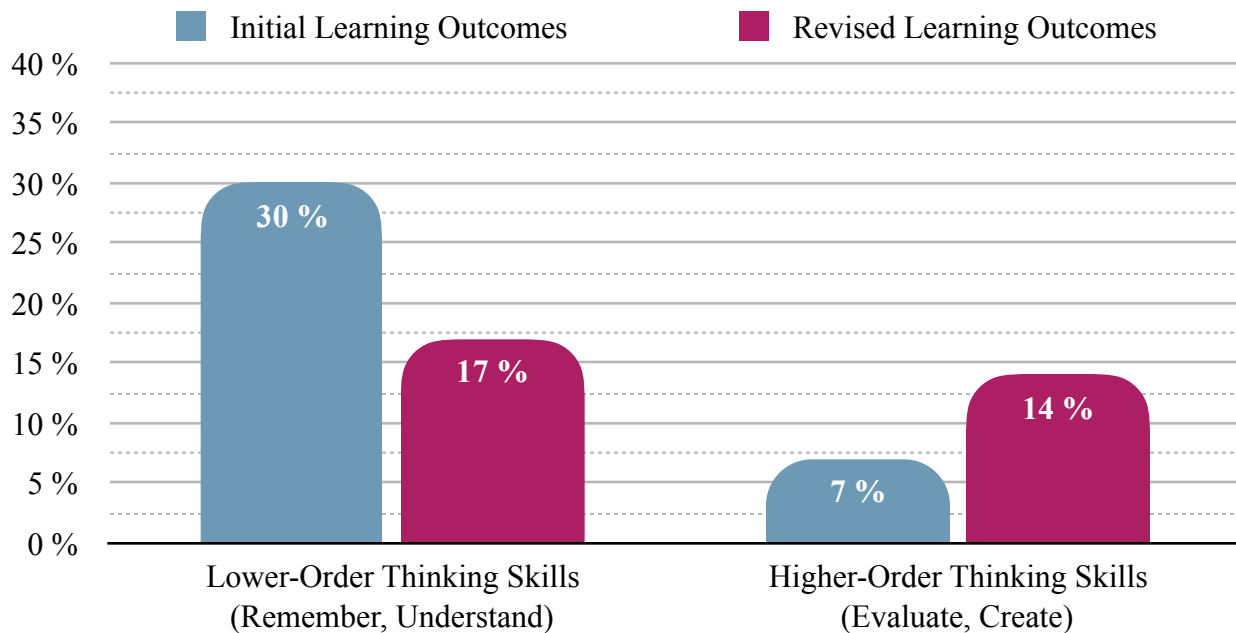


Figure 4. Average IMPACT course learning outcomes grouped

Using the same data set to focus specifically on engineering courses that have been redesigned through IMPACT can be seen in Figure 5 (n=62). The initial learning outcomes of engineering courses focused on lower-order thinking skills of Remember, Understand, and Apply. While there was a de-emphasis of Remember and Understand, there was a marked increase of Analyze

from 2% (n=1) to 13% (n=9). Future research will detail deeper analysis of these learning outcomes including if any findings are statistically significant.

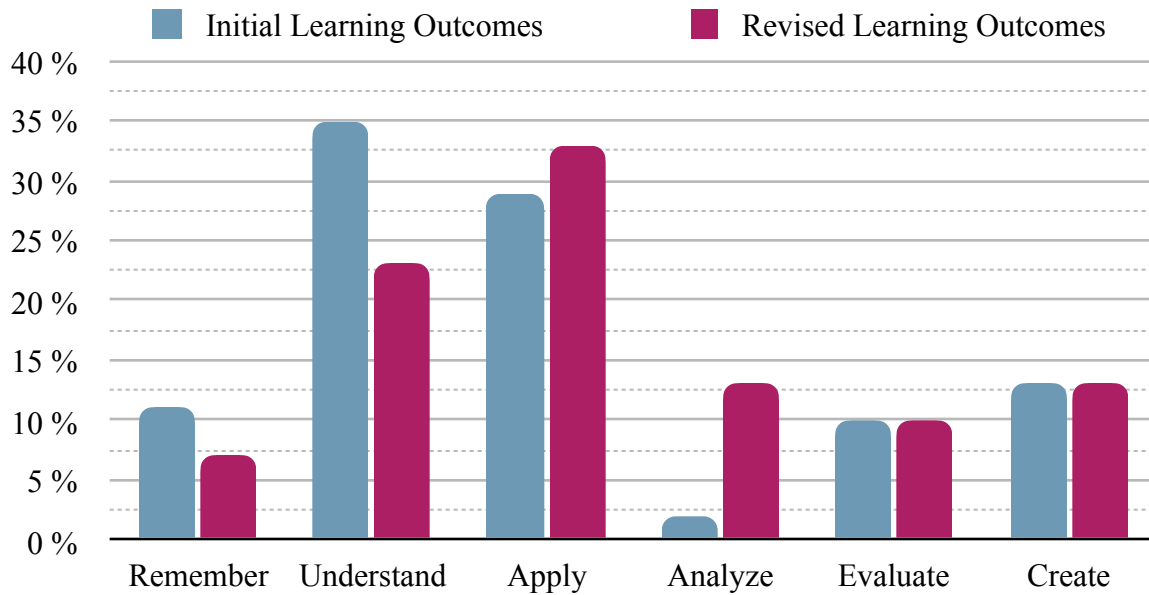


Figure 5. Percent of total learning outcomes for engineering courses (n=62)

This shift toward more learning outcomes focusing on Apply and Analyze has been beneficial for engineering faculty as it aligns more with ABET’s Student Outcomes (General Criterion 3)²⁷. Future research will explore how the revised learning outcomes influence student learning in engineering courses as well as address ABET accreditation. Specific inquiry will focus on exploring why there was no change in Evaluate and Create while there was a marked emphasis in Analyze between initial and revised learning outcomes.

Culture shift on campus

The effectiveness of IMPACT courses on student success and learning has spurred some colleges and departments to include participation in IMPACT as a metric of teaching development and effectiveness (Figure 6). The beginning of IMPACT required active recruitment of participants to create the community of faculty development support. Currently, no active recruitment is needed; faculty tell others and encourage their colleagues to participate.

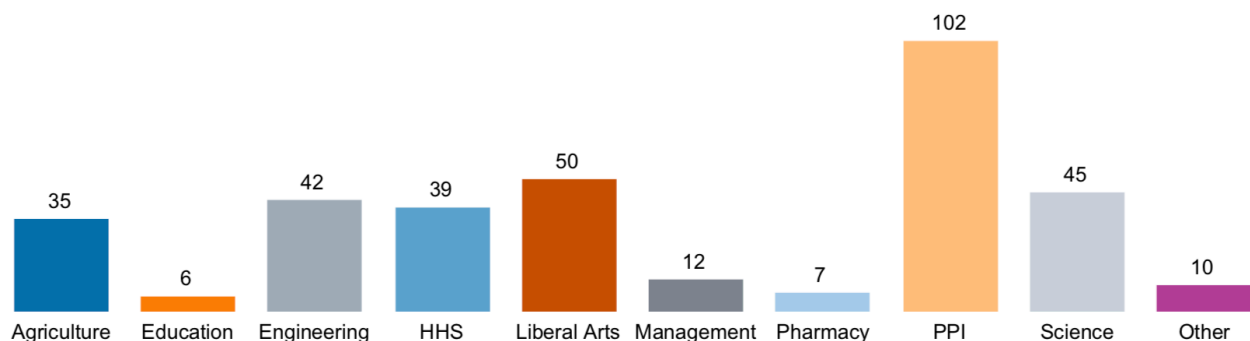


Figure 6. Number of faculty fellows that have participated in IMPACT by college

This large-scale, departmental involvement indicates buy-in by both faculty and administrators. (Note: HHS - Health and Human Sciences, PPI - Purdue Polytech Institute, Other - Honors, etc.) Over 75% of instructors who have participated in redesigning courses through IMPACT are from STEM disciplines.

Conclusion

Large scale attempts at sustained faculty development efforts to systematically improve the quality of undergraduate education are rare. However, there are faculty development programs that can have a positive influence on instructor efficacy, the quality of student learning, and institutional culture change. The IMPACT program at Purdue University (impact.purdue.edu) is one such program that has been recognized nationally by the Chronicle of Higher Education as a program that changes classroom culture².

One of IMPACT's primary strengths is the incorporation of SDT which provides the theoretical framework informing the structure and implementation of the program as well as the assessment measures operationalizing student-centered learning within classroom learning spaces. The cornerstone of the specific theory implemented in IMPACT focuses on three basic psychological needs that all individuals have: autonomy, competence, and relatedness⁴.

Focusing on the basic psychological needs of motivation in a faculty development initiative shifts the focus from redesigning courses and delivering a product to a holistic and professional faculty development experience. In order to effectively engage faculty participants, IMPACT provides faculty choice in their redesign elements (autonomy), acknowledges faculty perspectives and expertise (competence), and fosters a collegial environment with other faculty and support team members (relatedness).

An outcome of integrating SDT into IMPACT is that faculty members feel authentically engaged, view themselves as an integral part of the transformation process, and have agency in the process. A byproduct of success is evident in that previous IMPACT participants are recommending the program to their colleagues; the program reached capacity each semester before any active recruitment was required. IMPACT has specifically helped engineering faculty create learning outcomes while being mindful of ABET standards.

IMPACT represents a program that has been effective in improving attainment of course-specific learning outcomes and better alignment with ABET student outcomes as well as improved performance, improved student success, and by correlate, increased graduation rate. While student retention is not an explicit or intended goal of IMPACT, this paper shows the indirect impact of student retention in key STEM courses. The student learning data gathered for the IMPACT courses of Calculus, Chemistry, and Dynamics shows an improvement in the mean final grade and/or a reduction in the DFW rate. After participating in IMPACT, the instructors of these courses have experienced a marked improvement in student success with a reduction in

DFW rates by 20-30% through strategies specific to their context and needs²²⁻²⁴. Students in engineering courses who experience student-centered learning environments report significantly higher levels of perceived competence, autonomy, and relatedness as well as higher levels of self-determined motivation and perceived knowledge transfer (Table 2).

Challenges

The IMPACT program is managed and implemented through the collaboration of the CIE, TLT, and Libraries. Maintaining the integrity of the cross-unit collaboration is a continual challenge as the units are pulled in their individual directions. Identifying and preparing engaged, knowledgeable, and willing support team members from these units is also challenging as new personnel have joined over the program's history.

The second biggest challenge for IMPACT is trying to foster an engaged campus-wide program. Although faculty from every college has participated in IMPACT (see Figure 6), some colleges have low faculty representation, while other colleges have much higher representation. One of the tasks of the program is to work with academic leaders to help them understand the purpose and benefits of all faculty's volitional engagement in IMPACT.

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