



A Change Model Approach: Integrating the Evaluation of Synergistic Departmental Efforts to Transform Engineering Education

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Abstract

The Department of Electrical and Computer Engineering at a large Midwestern University is seeking to enhance undergraduate engineering education through a combination of programmatic efforts to create departmental change. Three distinct programs aim to transform ECE education through collaborative course design, enhancements to the department climate, and increases in the opportunities for underrepresented undergraduate engineering students. Due to the integrative and corresponding programmatic goals, it was vital to develop a unified evaluation in line with the program evaluation standards (Yarbrough, Shulha, Hopson, & Caruthers, 2011). Further, the interaction of multiple programs necessitated evaluating goal attainment at both the programmatic and departmental levels to determine not only the effects of individual programs but also to examine the broader effect of the interaction of multiple ongoing programmatic efforts to enhance engineering education.

To facilitate this process, program team members developed comprehensive lists of ongoing activities designed to create change in the department within each program. Evaluators worked with the program teams to thematically analyze and cluster activities into similar groups. To understand how each cluster of activities was positioned to create departmental change and revolutionize engineering education, the evaluators and team members then attempted to identify how each cluster of activities worked as change strategies within the model by Henderson, Beach, and Finkelstein (2011). Thus, evaluators were able to identify over twenty distinct clusters of change activities working as change strategies within the four pillars of the change model: Curriculum and pedagogy, reflective teachers, policy, and shared vision. Positioning activities within this model allowed the evaluators and team members to 1) Better understand the broad scope of departmental activities and change strategies, 2) Identify strengths and challenges associated with their current efforts to transform engineering education within the department, and 3) Develop and integrate ongoing evaluation efforts to further understand both the programmatic and interactive effects of having multiple programs designed at facilitating departmental change and enhancing engineering education.

The model for understanding department change and the approaches within that model that are being used to transform ECE education will be presented. We will further explain how the change model approach facilitated evaluating each program and the interactive effects of the combined programmatic efforts within the program evaluation standards of utility, feasibility, propriety, and accuracy (Yarbrough et al., 2011). Specific programmatic and interactive evaluation approaches will be discussed.

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Introduction

Researchers and faculty have long acknowledged the challenges with undergraduate STEM teaching. As such, many engineering departments are striving to shed antiquated policies and revolutionize department structures to enhance departmental climates, improve undergraduate education, heighten student retention, and increase student recruitment (particularly for underrepresented students). However, attempts to improve curricula are often met with limited improvement (Bok, 2006; Geisinger & Raman, 2013). Henderson, Beach, and Finkelstein (2011) noted that a weakness of many efforts to promote change in STEM education is that, “Research communities that study and enact change are largely isolated from one-another,” and reported that independent efforts to develop and distribute best-practice curricular activities or make top-down policy changes are not successful change strategies. Similarly, Kezar (2011) and Fairweather (2009) reported that efforts to fund individual faculty’s efforts to enhance educational efforts has failed to create comprehensive change. Bok (2006) reported that even faculty curriculum committees often failed to consider either relevant literature or the weaknesses of their undergraduate programs in a manner that facilitated departmental change.

In order to overcome the challenges associated with small-scale, independent efforts to improve undergraduate education, the Department of Electrical and Computer Engineering at a large Midwestern University is seeking to enhance undergraduate engineering education through a combination of programmatic efforts to create comprehensive departmental change. Three distinct programs aim to transform ECE education through collaborative course design, enhancements to the department climate, and increases in opportunities for underrepresented undergraduate engineering students. Independently, formative evaluation efforts have determined that these programs have brought changes to the department curriculum and course structures, departmental interactions and community-building efforts, departmental mentoring efforts, student recruitment, department recruiting efforts, and departmental partnerships with community colleges.

Due to the overlapping nature of the individual program goals and the department’s efforts to create broad change, adhering to the Program Evaluation Standards of utility, feasibility, propriety, and accuracy (Yarbrough et al., 2011) necessitated taking a comprehensive evaluation approach. This approach would enable an understanding of not just individual programs, but also allow us to gain an understanding of the ways in which the department was, and was not, changing as a whole.

Researchers have noted the importance of using theory of change to guide educational change efforts. Kezar, Gehrke, and Elrod (2015), for example, reported that academic change agents may have implicit ideas about change shaped by their disciplines, and that these misguided assumptions can lead to significant barriers if they fail to use a robust theory of change to guide efforts to create comprehensive changes.

Using the change model developed by Henderson, Beach, and Finkelstein (2011) allowed an examination of the complex and interacting nature of the change strategies being driven by the

department. This model consists of four categories of change strategies: Curriculum and pedagogy, reflective teachers, policy, and shared vision, as illustrated in Figure 1 below. The model is split from top to bottom on a focus on changing individuals (curriculum and pedagogy and reflective teachers) to a focus on changing the environment/structures (policy and shared vision). It is also split from left to right on a prescribed final condition (curriculum and pedagogy and policy) and an emergent final condition (reflective teachers and shared vision).

Using this change model approach to gain a broad overview of the change activities happening in the department would increase the utility and accuracy of the individual program evaluations and enable the department to:

- 1) Better understand the broad scope of departmental activities and change strategies.
- 2) Identify strengths and challenges associated with their current efforts to transform engineering education within the department.
- 3) Develop and integrate ongoing evaluation efforts to further understand both the programmatic and interactive effects of having multiple programs designed at facilitating departmental change and enhancing engineering education.

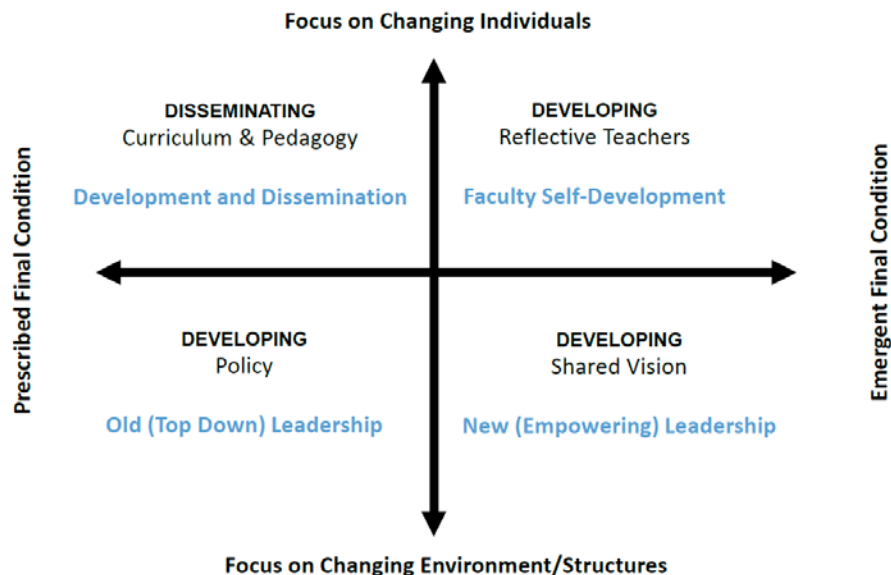


Figure 1. Change model by Henderson, Beach, and Finkelstein (2011).

Methods

Program leaders from each program (approximately 10 people per program) were invited to participate in focus/group activity sessions in order to better understand department activities and progress toward making departmental changes to enhance undergraduate education and increase opportunities for underrepresented students. Participating program leaders were given time to

write down examples of departmental activities and change tactics in which they had engaged within the past two years. The teams and evaluators then worked together to identify common themes and organize each of the identified change tactics into clusters of similar activities. This process revealed a total of 21 unique clusters, or common types of activities and change tactics.

To understand how each cluster of change tactics was positioned to create departmental change, the evaluators and team members then attempted to identify how each cluster of change tactics worked as change strategies within the model by Henderson, Beach, and Finkelstein (2011). This model consists of four categories of change strategies: Curriculum and pedagogy, reflective teachers, policy, and shared vision, as illustrated in Figure 1 below.

While some clusters of change tactics were potentially acting within multiple change strategies, each cluster was assigned to the most relevant change strategy in order to better understand the ways in which the teams' current change tactics were working together to revolutionize the department.

Results

The result of this activity is displayed in Figure 2 below. As shown, the teams identified six groups of change tactics primarily related to curriculum and pedagogy, five groups of change tactics primarily related to reflective teachers, four groups primarily related to policy, and six groups primarily related to shared vision. In additions, the team discussed research activities as a precursor to creating change. Each of these change strategies and the related groups of change tactics are discussed in more detail below.

CURRICULUM AND PEDAGOGY

- Making specific pedagogical changes including course redesign and developing classroom projects to encourage students' professional formation and academic success, and development of leadership skills
- Assisting department faculty to prepare education-focused proposals
- Engaging faculty in enhanced student mentoring and engaging students in peer-to-peer mentoring
- Engaging faculty in workshops related to design thinking
- Disseminating research results and information at professional conferences and in academic journals
- Leveraging campus resources to implement evidence-based best practices/programs

**Research:
Precursor
to change**

POLICY

- Collaborating between the three programs to understand and improve departmental policies
- Engaging in department strategic planning and updating departmental documents
- Updating departmental policies and practices to include professional formation in department courses
- Working with community college partners to enhance the recruitment of underrepresented students and offering student support through scholarship opportunities

REFLECTIVE TEACHERS

- Developing specific spaces and social opportunities for students
- Including undergraduate TAs on project teams and encouraging undergraduate input
- Making connections with academic advisors and undergraduate student groups and forums to understand student experiences and ideas and create a supportive and inclusive environment
- Engaging faculty in discussions about teaching to understand potential barriers to quality teaching, engage new faculty, enhance department understandings of inclusive teaching, share evidence-based teaching methods, and share program information
- Mentoring undergraduate students working with project teams and on related research

SHARED VISION

- Making strategic hires
- Engaging in interdisciplinary collaborations
- Discussing change programs and related goals in department retreats and faculty meetings
- Working with project teams to advocate for course enhancement, embed professional formation into coursework, adapt and use design thinking tools in teaching, etc.
- Collaborating through regular team meetings within the institution and with partner community colleges for reflection and discussion of research-related activities and results
- Developing and updating websites, social media forums, and department newsletters

Figure 2. Change tactics currently used by the ECE department.

The teams discussed current ECE educational research activities as a precursor to engaging in change tactics and creating change, due to the fact that the research results were used to do things like inform curriculum and pedagogy, train reflective teachers, make effective policy decisions, and guide shared visions. Specific research-related activities included things like IRB submissions and approvals, document reviews, classroom observations, and data collection and analysis. The team reported conducting research related to topics such as identity, marginalization, course design, empathy, and auto-ethnography.

Teams reported a number of efforts to enhance departmental curriculum and pedagogy. Several departmental courses were redesigned, using related research and stakeholder input, to emphasize design outcomes such as quality, innovation, student belonging, professional formation and leadership development, giving students more options in responsibility in final projects, and aligning final projects with ABET-mandated professional responsibility requirements. Teams also reported assisting faculty with proposal preparation to further fund related efforts in departmental change and enhancing undergraduate education. Teams also enhanced departmental mentoring efforts and strategies through faculty training, senior design teams, and the implementation of peer-to-peer mentoring programs. Teams trained faculty in evidence-based teaching methods such as design thinking through departmental workshops and departmental newsletters highlighting research findings. Curriculum-based research results were also presented at professional conferences and in professional journals. Teams additionally leveraged campus resources, such as the Women in Science and Engineering Program, to implement evidence-based best-practices and programs.

Teams also discussed efforts in the reflective teachers category. Teams developed specific laboratory spaces for students to use for collaborative studying and building community, and teams facilitated student community building through social events such as movie nights and weekly breakfasts. Teams recruited undergraduate TAs to participate on project teams and provide feedback about their experiences and suggestions for course redesigns and the department more broadly. They also held undergraduate forums, spoke with academic advisors, and contacted undergraduate student groups for feedback as they sought to improve student experiences in the department. They engaged department faculty in discussions about teaching to understand potential barriers to quality teaching, engage new faculty, enhance department understandings of inclusive teaching, share evidence-based teaching methods, and share program information. Finally, they also reported including undergraduate students on research related to the departmental change initiatives, mentoring undergraduate researchers, and encouraging students to present findings at professional conferences.

In the policy area, teams reported multiple efforts to collaborate between the three programs to facilitate shared understandings and shape departmental policies. They engaged in department strategic planning processes to update departmental documents to reflect these new understandings and departmental change efforts. They also updated departmental policies and practices to include professional formation in department courses. Additionally, they worked with community college partners to support and enhance the recruitment of underrepresented students and offer financial support through scholarship opportunities.

Team members identified six distinct strategies for creating a shared vision. Team members reported making strategic departmental hires to assist in the department change efforts and support the enhancement of undergraduate education. They also reported engaging in interdisciplinary collaborations in order to engage experts in education, student identity development, broader impacts, supporting underrepresented students in STEM, and other areas. They reported both sharing research and producing research with interdisciplinary researchers. They also described sharing program information and efforts at faculty meetings and department retreats in order to encourage reflection, obtain faculty buy-in, discuss research opportunities, and share evidence-based best practices. They worked with program teams to advocate for course enhancement, embed professional formation into coursework, adapt and use design thinking tools in teaching, and advance department change efforts. Finally, they reported developing and updating websites, social media forums, and department newsletters to include relevant program information related to departmental change efforts, research results, and program goals.

Discussion

Using a change model approach allowed an evaluation of the ECE department's efforts to create sustainable, comprehensive change. This was necessary to ensure that the department was using a variety of evidence-based change strategies to avoid the pitfalls of independent change efforts. Change efforts are often unsustainable because they fail to encompass the necessary scopes ranging from prescribed final conditions to emergent final conditions and a focus on changing individuals to a focus on changing environments. Using the change model allowed an evaluation of the extent to which change strategies were being implemented in each of these critical areas.

ECE program teams reported a variety of change strategies being implemented in each of the four quadrants. Six clusters of change strategies were identified for both the curriculum and pedagogy and shared vision quadrants, with robust strategies for impacting both students and faculty being reported in both areas. Similarly, five clusters of change strategies were reported in the reflective teachers category at the student, advisor, and faculty levels. Finally, four clusters of change strategies were reported in the policy quadrant, describing departmental policy changes and the implementation of policy changes related to community college transfer students.

Potential limitations that could be noted in the shared vision and policy areas could be that current efforts to create departmental change may fall short of creating broader change at the institutional level. For long-term sustainability, it is possible that creating a shared vision within the institution, greater institutional buy-in, and policy changes beyond the department would be necessary. However, the departmental change agents are implementing change strategies in each of the critical areas and collaborations have extended beyond disciplinary and programmatic boundaries in a way that is likely to create comprehensive departmental change.

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