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Capacity-Building to Transform STEM Education Through Faculty Communities in Learning Analytics and Inquiry

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Motivation and Goals

This capacity-building project, which is supported by the Institutional and Community Transformation track of the NSF Improving Undergraduate Education in STEM (IUSE ICT) program, is designed to build capacity for future efforts to support STEM faculty in collaborative inquiry processes to explore questions on student learning and success and to inform changes to improve individual classes, student pathways, and curricula. Recognizing that providing faculty access to data is not sufficient to effect change, this project aims to cultivate faculty interest and motivation in using evidence-based instructional strategies by including faculty as co-designers in the development of data analytics tools, engaging them in inquiry and developing stories prompted by the data, and in building community, both internally and externally. Thus, the project objectives are to: 1) expand learning analytics data tools that are relevant and actionable for faculty; 2) engage faculty in activities and learning communities that connect academic data with individual perspectives and values to motivate interest in evidence-based instructional strategies; 3) build community across STEM educators; and 4) refine theories of change and frameworks for a future change implementation project. The focus is on introductory, foundational, and gateway STEM courses. The capacity-building goals of this project are to strengthen the data infrastructure for faculty use and cultivate faculty buy-in for engaging in STEM education transformation to improve student outcomes at the University of Southern Indiana, which is a public, regional, primarily undergraduate institution (PUI) in the Midwest United States. Approximately 1,000 undergraduate students enroll in STEM majors in the Pott College of Science, Engineering, and Education, which has nearly 90 full-time faculty members in STEM.

Approach

The project's approach is guided by three assumptions and grounded in theories of change and evidence-based practices. The first assumption is that providing faculty with multiple ways to engage with student success challenges and evidence-based teaching will cultivate motivation to consider change in the classroom. Second, data alone will not drive change, but rather developing connections with data and evidence will help motivate transformation. A third assumption is that a systems thinking approach establishes an effective framework to organize efforts to implement change. Moreover, the expectancy-value theory of motivation with cost (Barron & Hulleman, 2014; Wigfield & Eccles, 2000) guides participatory and supported faculty activities to explore STEM teaching and student success topics (expectancy) while recognizing their participation (cost). Faculty are collaborators in the dashboard development, ensuring actionable data that answers meaningful questions to them (value). Acknowledging that data alone will not drive change, fostering an individual's connection with the data through their perspectives and a community with shared interests are needed. Also, communities of transformation or practice can be effective drivers to STEM education reform (Kezar & Gehrke, 2016; Shadle et al., 2017) and "significant conversations and significant networks" can influence faculty as they develop their understanding of teaching and learning (Roxå & Mårtensson, 2009). Moreover, narratives prompted by data engage individuals in sense-making while reflecting on

their beliefs, expanding their understanding, and cultivating shared meaning (Peterson, 2017; Gandolfi, 2019).

The project's overall framework for long-term change can be summarized as:

engagement + data + community (with stories as a thread) = motivation + knowledge --> transformation.

This capacity-building project to aims to enhance the left-hand side of the "equation." The project activities are designed to address key areas that need to be established prior to developing and implementing a program to engage and support faculty teams in widespread course transformation implementation projects that incorporate evidence-based instructional strategies. This project seeks to increase faculty awareness of issues and challenges in student learning, success, and retention in STEM introductory and gateway courses. This likely will increase their motivation to explore and try evidence-based instructional practices in their courses. This in turn likely will improve student learning and success in these courses as well as increase the retention rates of marginalized students and students with low-income, first-generation, and non-traditional backgrounds. Moreover, the project activities seek to build and strengthen faculty communities and networks and develop a culture of inquiry and conversations that are data informed. In parallel, faculty will participate in identifying datasets and learning analytics tools (e.g., dashboards, visualizations, reports) that will be used to inform instruction and curricular changes and improvements. This paper describes the activities during Year 1 (October 2020 to January 2022) of this NSF IUSE ICT capacity-building project.

Capacity-Building and Community-Building Activities

Multiple opportunities have been designed and implemented to invite faculty to participate in different levels of engagement. Reaching the broadest audience, Mini-Activities engage faculty and staff across all departments in the Pott College to explore student success and retention issues prompted by institutional data. These brief 15-minute activities are designed to prompt reflection, inquiry, and small group discussion using institutional data during the college-wide meetings held at the beginning of each semester. During the spring 2021, fall 2021, and spring 2022 semesters, approximately 125-135 faculty and staff members participated in the Mini-Activities via Zoom videoconferencing. The Mini-Activities provide a brief sample of the discussions on student learning, success, and retention and exploring program- or course-level data (i.e., learning analytics) and are used as a recruitment strategy for the Faculty Communities.

Two multidisciplinary Faculty Communities (FCs) have been intentionally fostered, with the purpose of fostering faculty motivation in exploring instructional and curricular changes and building community among faculty interested in student success and retention. Each FC meets bi-weekly to discuss student success and retention in introductory, foundational, and gateway STEM courses based on relevant articles, reports, and webinars. Faculty make note of their own questions and "I wonders" prompted by these resources, engage in conversations with their peers to explore and learn together, and build community through these interactions. The Inquiry in STEM Success FC focuses on exploring issues on improving student learning and retention while informed by institutional and national data and the literature. The Data Tools Co-Design FC also explores similar issues and participates in the development of use cases for and iterative testing of learning analytics dashboards that are actionable by faculty.

These activities aim to increase faculty's collective understanding in identifying bottlenecks and barriers to student success in STEM. During Spring 2021, over 80 Questions and "I wonders" were developed during the Data Tools Co-Design and Inquiry in STEM Success FC meetings. Afterwards, members of the Data Tools Co-Design FC identified preliminary themes and codes of these questions - by data category, when faculty would use the data, and the purpose of the data. These themes and questions sets then were used to prioritize actionable data that would help faculty make instructional and curricular decisions and changes.

For this project, "community" is defined as a group of individuals who hold regular conversations about a common interest (i.e., improving STEM education and student retention). To date, a total of 17 faculty members have consistently participated in either or both FCs, with 7 participating in the Data Tools Co-design FC and 14 participating in the Inquiry in STEM Success FC, and most participants continuing across semesters. At the end of the Spring 2021, FC members were asked, "Have you had conversations sparked by or as a result of participating in the FCs?" Sample responses include:

- *Yes, a small group of faculty in my department participated in the same Faculty Community, and this has led us to the beginnings of working together on ways that may improve student success in [math]. Because of the pandemic, I hadn't been having many conversations about teaching and students' learning because I just haven't been seeing my colleagues as often as I had been prior to March 2020. Because of that, participating in this Faculty Community ended up making a big difference for me because those conversations about how students are struggling with this or they didn't seem as receptive to this lecture (and getting ideas on what I might try to do to help them) just hadn't been happening so much.*
- *Not so much with others, but I have thought about how impactful the changes we make in class are as in how we may teach a class and how that impacts student outcomes. So, I've become more mindful of how our choices as faculty influences students and their success. I am hoping to talk with others soon about the courses that I teach and how we might be able to fuel students motivation and help curb the stigma about how "math is hard".*
- *I have had numerous conversations with my colleague who teaches the same class as me especially as it relates to the preparation of students who enter the sequence of courses.*

Initial Lessons Learned and Next Steps

Several effective strategies and lessons learned have surfaced from this capacity-building project so far. In recruiting faculty participation, having a multi-pronged approach can be effective in addition to the college-wide Mini-Activities themselves. For example, college-wide emails were sent after Mini-Activities to recruit FC participation. Additionally individual invitations were sent to faculty members who were suggested by department chairs and to recently tenured and promoted faculty members. This has helped to expand participation beyond faculty members who already are interested and engaged in course transformation and student retention efforts.

Additionally, the development of the learning analytics dashboards, which has involved the Data Tools Co-Design FC, project team, and external consultants, has taken longer than anticipated due to technical logistics and frequent communications with and across the stakeholders. Defining the specific data use cases for the dashboards is iterative between these groups. The

early and ongoing involvement of the faculty in the design of the dashboards is expected to result in more interest and motivation in using these learning analytics tools to wider groups of faculty members. Moreover, institutional change models and learning analytics tools are more common in large, research institutions, which have the infrastructure. The culture, resources, and infrastructure are often more limited at a mid-sized, regional, comprehensive PUI institution such as the University of Southern Indiana, thus requiring context-specific considerations when adapting existing models.

Several next steps are planned. One is further development and refinement of the data dashboard with the Faculty Communities. The second initiative is to introduce storytelling with the FCs to capture their reflection on their journey to better understand and take action on student learning and retention issues and then use these stories to share with others to help motivate additional faculty engagement. Another ongoing task is further testing the project assumptions and theories of change to refine a framework to cultivate motivation and change to improve student success and retention and incorporate evidence-based instructional strategies.

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