ACTIVE RESEARCH AND GRANTS

Investigating Classroom Discourse in Active Learning Environments for Large Enrollment Chemistry Courses

With support from the NSF Improving Undergraduate STEM Education Program: Education and Human Resources (IUSE: EHR), this project aims to serve the national interest by investigating factors that create effective classroom environments for large undergraduate chemistry courses. To accomplish this goal, the project will gather data from large enrollment courses at the University of Iowa, the University of Arizona, Middle Tennessee State University, and Stonybrook University. It will use these data to determine the features of collaborative activities that foster high-quality student engagement and meaningful learning. Special attention will be paid to the participation of diverse student populations, such as first-generation college students and English-language learners. Core findings from this research project will be used to develop and disseminate faculty resources that will support creation and implementation of effective classroom activities.

The research design for this project is based on the understanding that collective activity is a sociological construct that fosters the construction of ideas through different patterns of interaction. Productive ways of reasoning emerge as learners solve problems, explain their thinking, and represent their ideas when engaged in well-designed and relevant tasks that are properly facilitated. Thus, at the center of the research design is the observation, recording, and analysis of student-student as well as student-facilitator conversations to: a) characterize critical characteristics of collaborative task facilitation that most strongly support productive engagement; b) explore how different features of task design (e.g., structure; focus; cognitive demand; opportunities for knowledge integration; co-construction of knowledge) affect students’ modes of reasoning and productive engagement in argumentation and explanation; and c) characterize the interaction of task design and facilitation with student discourse in large chemistry classes and determine how those interactions hinder or facilitate the productive engagement of diverse students by reducing barriers to their equal participation in and contribution to group work.

PI: Dr. Gregory Rushton

PDConnect: A Scalable Community Approach to Improving Instruction in AP Chemistry Nationwide

In this project, researchers propose to develop an online teacher-professional development community (PDConnect) that leverages social processes hypothesized to be central to the diffusion of teaching reform. Students need to be better prepared to participate in a workforce which evolves as rapidly as the technological advances that drive the U.S. economy. Consequently, educators are faced with the task of both
fostering student proficiency on the current state of knowledge, and preparing them to remain proficient in the future. To adopt reforms in practice, teachers need to be aware of practices informed by evidence-based research and know other teachers in other schools who have adopted new practices. The intervention consists primarily of a comprehensive collection of resources and an online professional development community for AP Chemistry teachers. Researchers will utilize web-based small-group peer discussion system (Talkabout) to refine the site and to maximize the mechanisms used to create peer discussion groups. This project will run from September 2018 to August 2021.

PI: Dr. Gregory Rushton  
Co-PI's: Chinmay Kulkarni and David J.Yaron

**Teacher Leadership: Investigating the Persistence and Trajectories of Noyce Master Teaching Fellows**

The overarching goal of this collaborative Noyce Track 4 Research project is to contribute to the currently-limited understanding of STEM teacher leadership by examining the influences of teacher leadership development on the persistence and professional trajectories of Noyce Master Teaching Fellows (MTFs). The Teacher Leadership (T-Lead) project plans to gather data related to the nature and structure of seven currently active Noyce MTF projects, the professional trajectories of participating MTFs, the school contexts in which the MTFs teach, and the leadership activities in which they engage. This data set will allow the project team to address two main research objectives. The first is to determine the impact of the professional learning models used in the various Noyce projects on the professional identities and trajectories of participating MTFs, and look for patterns in the features of those models that may be correlated with teacher persistence. The second is to explore how different contextual factors (e.g. STEM teaching responsibilities, school culture), professional networks, and leadership opportunities shape the decisions of MTFs to remain in classroom roles during and/or after the Noyce program. This project is estimated to run June 2018 to May 2021.

PI: Dr. Gregory Rushton

**A Research Study of Teacher Retention and Network Formation in Noyce Communities of Practice**

This Noyce Track 4 Research project is a collaborative endeavor to examine teacher induction as an aspect of teacher preparation that affects the way teachers become embedded within their professional community. It will look at how being a member of a specific Community of Practice (CoP) influences teacher identity, belief in their personal teaching abilities, and desire to remain in the profession related to teacher retention. The universities in this study span the U.S. and represent successful Noyce teacher preparation programs with a variety of recruitment strategies (e.g., career changers),
induction support structures (e.g., online), and teacher placements (e.g., rural vs. urban). These six sites will also allow for a comparison of Noyce and non-Noyce teachers emerging from the different teacher preparation programs. The goal is to determine whether a core set of program features contributes to the success of each induction program, or if distinct program features are useful for unique populations (e.g., periodic face-to-face meetings for career changers, or online support for urban teachers). The project also seeks to determine which program features lead to different community structures (e.g., collaborating mainly with teachers inside or outside the school), and how that community affects a teacher’s perception of the profession (e.g., teacher is connected to professionals across the state and wants to remain in the profession as a career). This project is running from April 2017 to March 2020.

PI: Dr. Gregory Rushton
Co-PI's: Gillian Roehrig, Brandon Ofem, and Michael Beeth

**Student Engagement in Statistics Using Technology: Making Data Based Decisions**

Middle Tennessee State University's Dr. Ginger Holmes Rowell serves as a Statistics Education Consultant for the “Student Engagement in Statistics Using Technology: Making Data Based Decisions” NSF IUSE proposal at Grinnell University (#DUE-1712475), which is a project to develop realistic video games to help students learn statistics and instruments to assess their ability to help students learn important statistical concepts. Dr. Rowell assists in the following:

- The development of a new assessment tool in collaboration with Dr. David Lopatto,
- Test early drafts of games and corresponding lab activities in her own statistics classes,
- Coordinate class testing at MTSU of the games and corresponding lab activities; and
- Help organize and host a one-day workshop at MTSU for MTSU intro statistics teachers.

The grant is expected to run from June 1, 2017 to May 3, 2021.

PI: Dr. Ginger Holmes Rowell
Supporting K-12 STEM Educators to Develop their Teaching and Leadership Practices

The future STEM success of our nation’s children is largely dependent on the STEM teachers they encounter from prekindergarten to Grade 12 (Pre-K–12). Teaching STEM effectively requires teachers to be life-long learners. Professional development provides one avenue to support teachers with this need to continue to learn. This study will conduct design-based research about TSEC’s current professional development opportunities for STEM Teachers. This study will investigate the following research questions:

- What pedagogies of enactment and investigation do teachers authentically engage in during professional development opportunities?
- How does the design and facilitation of professional development opportunities provide opportunities for teachers to engage in pedagogies of enactment and investigation?
- How do professional development opportunities provide support for and develop teachers’ ability to engage in continuous improvement after PD programs?
- What role do classroom artifacts, such as student work or classroom video, play in professional development opportunities?

PI: Dr. Elizabeth Dyer
Designing Informal STEM Outreach for K-12 Students to Engage Students in Authentic STEM Practices and Develop Positive STEM Identities

Opportunities outside of traditional STEM courses in K-12 schools can provide a valuable way for students to develop knowledge, attitudes, and interest in STEM subjects and careers. Additionally, there is unequal distribution of and access to quality STEM learning experiences for individuals, family, and communities outside of schools. This study will conduct design-based research about TSEC’s current STEM outreach programming for K-12 students to better understand how they support students’ STEM pathways and how to redesign the programs to have greater impact. This study will investigate the following research questions:

- What STEM practices do students authentically engage in during STEM outreach programs?
- What types of STEM identity work do students engage in during STEM outreach programs?
- How does the design and facilitation of STEM outreach programs support students to authentically engage in STEM practices and develop positive STEM identities?

PI: Dr. Elizabeth Dyer

The Structure of High School Math Lessons: A focus on visuospatial and acoustic aspects

Developing theory about learning in STEM classrooms requires understanding not only learners’ conceptual development, but also how interactive (i.e., social and spatial) aspects of classrooms are integral parts of student learning. For example, aspects such as the nature of collaboration, use of gesture and embodiment, the nuances of discursive tone and prosody, and student positional identities are important for understanding learning in STEM classrooms. In this study, we are developing methods for how to analyze the interactive aspects of videos of high school mathematics classrooms, focusing on the visuospatial and acoustic features of the video data. The study will qualitatively and quantitatively analyze videos from different high school mathematics classrooms to investigate the following research questions:

- How are different participation structures used during mathematics lessons?
- What forms of interpersonal and person-material interactions are present during mathematics lessons?
- What forms of productive struggle are present during students’ math problem-solving?

PI: Dr. Elizabeth Dyer
Supporting Science Teacher Learning through Capturing and Selecting Video of One’s Own Classroom

Video has been a central part of efforts to support science teacher learning for over twenty years. Previous research has shown that discussions about classroom video, such as analyzing the student thinking shown in a video, has the potential to support science teachers to improve their teaching over time. New technology, such as action cameras, smartphones, and 360-degree cameras allow teachers to easily capture video of their own classroom rather than rely on using video from existing sources. This study investigates how using these new technologies can provide additional opportunities for teacher learning prior to the viewing and discussion of video with colleagues when teachers engage in capturing video from their own classroom and selecting clips to share with others. This study examines science teachers’ discussions and written comments to investigate the following research questions:

- What practices and ways of thinking do teachers use when (1) prior to, (2) during, and (3) after capturing video of their teaching?
- How do those practices and ways of thinking show evidence of teacher learning?
- How are teachers’ practices and ways of thinking connected across the three phases of the capturing process?

PI: Dr. Elizabeth Dyer
Learning through Teaching: Math Teachers' Use of Classroom Experiences as Feedback

The reform movement in mathematics education, most recently supported by the new Common Core Standards, calls for a new approach where teachers are expected be responsive to student thinking by noticing and building upon students' emerging understanding. Some exemplary teachers undergo these changes just through learning from their classroom experiences to become more responsive. This study uses an innovative method for studying teachers' in-the-moment sense-making when learning from classroom experiences where teachers collect video from their point-of-view using small wearable cameras (e.g. GoPros). The camera records the previous 1 minute of action when the teacher presses a button, such that teachers can save video clips of a notable moment after it has occurred. Shortly after the lesson, the teacher is interviewed about the moments to uncover what they noticed and how they made sense of those moments. This study will analyze the videotaped post-lesson interviews with teachers to investigate the following research questions:

- What kinds of moments during lessons do math teachers identify as useful to learn from or relevant to how they are trying to improve their teaching?
- How do teachers use causal reasoning (i.e. understanding what causes events to happen in their classroom) to make sense of their classroom experiences?
- How do teachers learn and improve from both successes and problems they experience in their teaching?
- What kinds of changes do teachers propose to make to their teaching when they learn through experience?

PI: Dr. Elizabeth Dyer