Belonging, advocacy & community in STEM teaching & learning

Kate Cammack (Psychology/Neuroscience) & Kristen Cecala (Biology)

1. Why inclusive teaching in STEM?

A massive movement is underway to re-envision undergraduate education in science, technology, engineering, and mathematics (STEM). For example, AAU, AAC&U, NSF, the National Academies, AAAS all have initiatives to develop and promote new approaches to STEM teaching and learning in response to national-level statistics demonstrating that current academic systems fail to recruit, retain, and support students of underrepresented groups, which translates to a less diverse and innovative workforce. Progressive, evidence-based approaches that improve STEM teaching and learning impact undergraduate students' interest, sense of self-efficacy and belonging, and persistence in these disciplines (e.g., here). These practices are particularly impactful for students historically underrepresented in the sciences, who are currently less likely to remain in STEM, declare a STEM major, and/or graduate with a STEM degree. SLACs funded through the HHMI Capstone Awards have piloted and shared effective strategies that promote equity and inclusion in science programs, including innovative curricula, community building initiatives, professional development opportunities, and intentional mentoring practices (e.g., this). Importantly, these efforts can co-occur in classroom, co-curricular, and mentoring spaces, providing both faculty and students with many intersecting opportunities and paths for progress with various levels of investment. However, these progressive and evidence-based practices are less effective without transformative institutional change (Lerback et al., 2022).

2. Why inclusive teaching in STEM at Sewanee?

Sewanee's efforts towards improvement in the past 5-years have been focused on two key areas. First, the U.S. population is becoming increasingly diverse and the number of high-school graduates is expected to decline. Second, Sewanee's retention rate lags behind our peer and aspirant groups. Thus, the institution has prioritized efforts to promote success of all of our students both in and out of the classroom. These dual efforts are important to promote resilient cultures that allow students of all identities to feel that they belong and can be successful at Sewanee. If STEM disciplines tend to exclude students with diverse identities, then this is the key academic area where cohesive, coordinated, and evidence-based approaches would be particularly effective. The investment of most of our peer and aspirant institutions to develop solutions illustrates the need within our student population and one way in which our academic programs may be falling behind our peers. Likewise, this gap offers an opportunity for us to apply solutions that have been tested within populations and contexts similar to Sewanee.

At Sewanee, resilience frameworks rely too heavily on individual-level interventions that are typically opt-in and/or on a "volunteer" basis leaving students with uneven and disjointed experiences and placing additional burdens on faculty who opt-in. Rather than promoting resilience within current structures, we should be considering ways to transform our systems in innovative, out-of-the-box ways (Lerback et al., 2022). As a SLAC, Sewanee has an unrealized opportunity to build forward-facing, formalized, evidence-based programs that promote both scientific identity and self-efficacy amongst our students (Jayabalan et al. 2021). At the individual level, transformations would work to (1) improve retention by smoothing students' transition to college, (2) improve academic success and entry to STEM majors by enhancing engagement with STEM coursework, (3) improve persistence in STEM majors by cultivating a sense of belonging within the major, and (4) set up our students as leaders by supporting transitions to purposeful career paths.

Sewanee has additionally valuable opportunities to explore STEM in a liberal arts context and cultivate an appreciation of and engagement with STEM that lasts far beyond graduation. Ultimately, expanding students' sense of belonging in STEM will help broaden the diversity of students who pursue, persist in, and complete those majors/minors. NSF and other funding agencies like HHMI all consider broadening participation of diverse groups in STEM workforces as an essential component of keeping our nation's industries and economy competitive on the global stage. Current events and lack of science literacy broadly underscores the importance of forming citizen scientists who support data-informed policies and choices.

Supporting coordinated diversity, equity, inclusion, belonging, and justice (DEIBJ) transformations in STEM is not only the ethical approach to teaching but would help the institution achieve key milestones as we work to offer a rigorous and humane education that allows all students to flourish. This work ties together three of the four pillars of the University Foundational Plan – Curriculum Renewal and Innovation, Equity and Inclusion, and Student Success – and offers a cohesive, interdisciplinary approach that will improve teaching and learning in ways critical to SACSCOC accreditation and consistent with potential Quality Enhancement Plans. Supporting the goals below will identify synergies between the College faculty, Division of Diversity, Equity & Inclusion, Student Success, and others, and provide a cohesive set of experiences that will enrich our campus community.

3. What do we hope to achieve?

A broad goal is to implement transformative, evidence-based changes in STEM teaching and learning that will help maintain Sewanee's competitiveness relative to our peer and aspirant groups. In the process of evaluating, adopting, and assessing new DEIBJ-centered practices, we will be able to develop truly innovative, data-driven directions for Sewanee's STEM programs and apply to an HHMI-type grant supporting transformative undergraduate STEM education. Within the context of this proposal, we plan to (1) implement changes to build self-efficacy in STEM with a focus on underrepresented groups and (2) collect and evaluate data from multiple campus sources in order to identify and prioritize the key challenges to DEIBJ in STEM at Sewanee.

GOAL 1: Build students' self-efficacy in STEM, especially in those historically excluded from STEM

Self-efficacy is the belief that you contain the skills, knowledge, and resources to succeed. Many evidence-based practices, rooted in the scholarship of teaching and learning, exist and translate to our campus in fairly accessible ways. In many ways, Sewanee needs to catch up with many of these practices by updating our pedagogies and practices in data-driven ways (e.g., this, this).

Aim #1: Promote science identity & the value of DEIBJ in STEM

> *Approach 1. Develop a course for STEM-interested students that directly addresses DEIBJ in STEM.*
> Being Human in STEM (HSTEM) is a course initially developed at Amherst and adopted or currently being considered at several similar SLACs including Centre, Davidson, Hendrix, Mt. Holyoke, Rhodes, Skidmore as well as larger institutions like Yale and Brown. The course has two phase: the first phase explores qualitative and quantitative data related to DEIBJ in STEM, and their underlying causes & frameworks (e.g. stereotype threat, imposter syndrome), while the second phase involves project-based learning focused on improving concrete DEIBJ-related issues in STEM at Sewanee.

This spring, we will be teaching parallel sections of this interdisciplinary course (NOND130) for the first time at Sewanee. We will be assessing key outcomes of this course, using tools related to science identity and belonging (e.g., this, this) . Student-developed projects will also be an opportunity to lay the foundation for several of the ideas presented below.

We have several other goals for this course. First, in order for this course to have measurable, longer-term impacts, we will need to develop a realistic, cost-effective, and sustainable teaching plan for NOND130, given the tight teaching units amongst STEM faculty. Part of this effort will be recruiting and training faculty to offer this course regularly. Second, this course has two general education attributes (G5/G7), but it is also a valuable requirement for 21st century STEM programs. We plan to discuss with STEM departments about how this course could be included in their existing major or minor criteria. Third, we will develop a Student HSTEM Fellows Program, which will train and compensate student leaders in vertical mentorship positions within the NOND130 course and the HSTEM Club (described below).

Deliverables:
(1) Assess key outcomes of HSTEM course (NOND130), to be shared with college faculty
(2) Create HSTEM curriculum, resources, & teaching guides for other faculty interested in teaching NOND130, and hold an informational session and/or workshop orienting faculty to these materials
(3) Develop a plan for a sustainable future for HSTEM course (NOND130)
(4) Develop training program/materials and structure for Student HSTEM Fellows program

Approach 2. Build faculty confidence & competence in implementing inclusive practices
Following the 2021 Posse Plus Retreat, participating STEM faculty heard that faculty and students perceived DEIBJ issues and initiatives as separate from STEM disciplines, rather than interwoven. In response, in Fall 2021, a small group of faculty initiated the co-curricular Science Friday (SciFri) program to unpack hidden STEM curricula and address DEIBJ issues within STEM directly. Over the past three years, these monthly sessions have been well attended (~10-50 students) and drawn many students from backgrounds historically excluded from STEM (e.g., female, first-gen). However, these co-curricular sessions were held outside of existing course structures, limiting the number of students and faculty who were able to attend.

In Spring 2023, as we began to prepare to teach HSTEM, we realized that STEM faculty are generally undertrained (and thus not confident or experienced) in approaching DEIBJ issues in their classrooms. In Summer 2023, we co-facilitated an Associated Colleges of the South book group with eight STEM faculty from five ACS institutions, which provided concrete ideas, shared experience, and practice facilitating conversations on challenging topics. We also completed an NSF-funded facilitators training on DEIBJ in STEM, which prepared us to offer a faculty learning community (FLC) on our campus this past fall, which was completed by seven faculty participants from seven STEM majors.

Transformative institutional change involves a critical mass, and then a majority, of STEM faculty who are confident and competent in implementing DEIBJ-centered practices in their classrooms and laboratories. We see two primary goals here: we need to develop buy-in among our STEM colleagues across disciplines, and we need to make these efforts sustainable. First, we will develop a sustainable model for the Inclusive Teaching in STEM Faculty Learning Community. Second, we will co-develop a series of STEM-focused DEIBJ sessions with the Center for Teaching to provide our STEM faculty some evidence-based approaches, cultivate comfort and confidence to implement these approaches, and develop changes/deliverables to implement in their classrooms. Third, we will meet with STEM chairs and departments/programs to discuss potential DEIBJ-specific goals and how to incorporate DEIBJ-related approaches into departmental assessments and practices. Finally,

we will explore cross-institutional, collaborative discussions on inclusive STEM teaching & learning at departmental, divisional, and institutional levels (e.g., Centre's entire chemistry department adopted non-traditional assessment approaches).

Deliverables:
(1) Select & support 2-3 HSTEM Faculty Fellows to partner with us in the work described above.
(2) Coordinate 2 Center for Teaching events on inclusive teaching in STEM.
(3) Develop repository of STEM-specific DEIBJ resources to share with STEM faculty
(4) Consult & ideate with STEM departments/programs about potential approaches & assessments

Aim #2: Build students' capacity & resources to enter, persist, and succeed within STEM

Approach 1. Vertical mentorship & community building in co-curricular spaces.

As students spend more time outside of the classroom than in the classroom, a supportive culture that extends beyond the classroom is essential. Faculty time is limited and students are primed to take a greater role in promoting self-efficacy and belonging within STEM. Student to student mentorship networks can teach explicit strategies for navigating STEM fields at Sewanee from their peers, provide an academic "home" for students that enhances their sense of belonging, and cultivate a stronger sense of scientific identity and community.

We propose two student-led programs. First, we plan to train student leaders to coordinate and guide facilitated study groups (FSGs). Facilitated study groups are optional, informal sessions that allow students to learn alongside their peers and a student facilitator (who previously took that course) to identify new strategies and ways of understanding that work best for them. Students get to know their classmates better (contributing to academic belonging) and their facilitators, which helps establish a vertical mentorship structure. Facilitate study group participation has been linked to better course performance and greater sense of belonging at college and in STEM fields, and can offer students who are unable to participate in more formal tutoring programs (e.g. SHPS tutoring for key pre-health courses) opportunities for support. Kate piloted two facilitated study groups this past fall (NEUR101 & PSYC350).

Second, we propose to co-create an HSTEM Student Club that would broaden participation and promote lasting change on campus. As HSTEM (NOND130) only lasts one semester, a co-curricular student group could extend the student-driven projects beyond the HSTEM (NOND130) course itself. This co-curricular group would be a way for students to contribute to action-based research, advocacy, and project implementation on campus.

Deliverables:
(1) Evaluate our pilot facilitated study group (FSG) outcomes to inform future implementation.
(2) Develop the training program for FSG facilitators.
(3) Co-create goals & structure of HSTEM Club, including faculty advisor(s), student leadership, and funding

Approach 2. Unpack hidden curricula to level the playing field

One factor contributing to unequal preparation among students with different identities are the knowledge and support they have as they navigate the elements necessary to prepare them for success in STEM. The hidden curriculum disadvantages any student without strong mentorship and individual investment in their future. Although Sewanee is known for its close student-faculty interactions, faculty time and investment in mentorship is unevenly distributed among students and subject to implicit biases. From a faculty perspective, repeating key information to all students is

time consuming. Thus, we have piloted a few ways to improve communication between faculty and students to support equitable access to information and a first place for students to start when they are seeking information about how to be successful, how to find summer jobs, etc.

First, on Brightspace, we piloted open-access Brightspace pages for particular STEM programs (e.g., Biology, Neuroscience) that allow any interested student to access information in more equitable and transparent ways. Program-specific courses include information specific to Sewanee (e.g., about faculty, co-curricular opportunities, study-away), the discipline itself (e.g., career paths), and affinity groups (e.g., Black in Neuro, 500 Queer Scientists). Over the next year, we plan to advertise and provide support for broader adoption of these approaches and construct an interdisciplinary site for STEM with more expansive DEIBJ content.

Second, Science Fridays (SciFri) are now in their third year. Approximately monthly during the academic year, we invite STEM faculty and all students to join together in discussions about identity in STEM and co-curricular opportunities. Our most successful SciFri events have focused on how to get involved in faculty research and how to identify and apply for summer opportunities in STEM (~30-50 students); these events allow all faculty interested in engaging students to meet with interested students over a short period of time, lowering the barriers for students to approach faculty about work with them. We would like to identify, orient and support new faculty in taking leadership roles in this program, as a means of reciprocal faculty-faculty mentorship and also to expand the network of our faculty involved actively in DEIBJ-related programming.

A disadvantage of the co-curricular SciFri approach is that important pieces of information are being shared at times when students may be unable to attend. Kate is a 2023-25 Faculty Fellow for Career and Purpose, and her goal within this program is to explore the potential to offer a for-credit course to overcome this obstacle. This potential course would explore equitable approaches that help STEM students identify their interests, articulate soft/translatable skills, and explore potential pathways/careers, in partnership with Center for Leadership, Student Success, and Career Readiness. While her initial targets were majors/minors within her home departments (Neuroscience & Psychology), this grant could support her efforts to engage other STEM departments in co-creating a sustainable, interdisciplinary course.

Deliverables:
(1) Offer a workshop for STEM departments about building open access Brightspace pages.
(2) Build an open-access HSTEM Brightspace page, targeting pre-major students
(3) Recruit & support faculty to coordinate and contribute to SciFri programming
(4) Meet with STEM departments to gauge interest in co-creating/adapting a for-credit course for student wayfinding in STEM.

GOAL #2: Identify opportunities and needs in Sewanee STEM to design progressive interventions

Given the trends in both higher education and our national context, much has been written about national deficiencies in STEM education. However, every institution has its strengths and challenges, and without a clear picture of which are ours, it will be difficult to develop the most effective and targeted interventions for our student population.

Approach 1. Perform a university-wide needs assessment to identify obstacles to students in STEM

Understanding patterns of student success is essential to identify the obstacles that pose the biggest impediment to students. Furthermore, identifying when these obstacles occur in a student's educational path will allow us to refine what types of interventions will be most effective and who

would be best to implement those changes. For example, what students need to be successful at the pre-major stage may be very different than what students need as they begin to transition to their life beyond Sewanee, and the interventions may need to shift in focus from broad advertisement and availability to more nuanced and individual-based approaches. Many datasets are already collected by the institution and simply need analysis at the departmental or discipline level, but these datasets largely target the outcomes rather than the factors that contribute to those outcomes. For example, information is available about incoming interest in a major and whether or not a student remains at Sewanee and graduates within one of their top ranked majors. We also have first job data for most of our alumni to evaluate the relative success in how majors prepare students for future careers in STEM.

We propose to collaborate with Institutional Research, the Office of Admissions, Student Success, and the Office of the Dean of the College to analyze quantitative data about student retention, success, and outcomes, particularly as they relate to identity factors and disciplines. To do this, we will need to aggregate data sources from multiple offices at Sewanee. We will also perform a mixed-methods approach from students, faculty, and staff to identify concerns during recruitment and retention in STEM, obstacles that prevent students from engaging, persisting, or succeeding in STEM, and factors that contribute to science identity and self-efficacy. We anticipate that most of the upcoming year will be spent on survey design and IRB approval.

Deliverable:

(1) Report, to be shared with college faculty, summarizing:
   (a) existing & new data collected from from students, faculty, administrators, and staff specifically about DEBJ in STEM on our campus
   (b) themes relevant to specific stages (e.g., major entry) of students' experience with STEM at Sewanee

Approach 2. Propose novel interventions that address the rapidly changing future of STEM

If the data analyses in the previous approach warrant substantive improvements, which we anticipate, we would like to explore submission of an institutional scale grant for innovation in inclusive STEM teaching. STEM as a group of disciplines is changing rapidly to keep pace with advances like artificial intelligence and adapting to global challenges like rapid climate change. These provide opportunities for us to consider how to position Sewanee students for a future that is difficult to predict. Our goal by the end of the year will be to have identified and extended invitations for an Advisory Committee in Inclusive STEM Teaching that would be responsible for developing a proposal and overseeing any potential future award.

Deliverable:

(1) Create an advisory committee dedicated to seeking external funding for inclusive STEM teaching at Sewanee.

4. What are we asking for?

We wish to support ongoing and new efforts to systematize inclusive programming, teaching, and community in STEM at Sewanee. Our overarching goal is to promote a community that openly discusses systemic issues and disciplinary obstacles for underrepresented groups and generates solutions to these issues. Specifically, we hope to incentivize faculty to use data-informed approaches to improve retention and belonging of underrepresented groups in STEM and implement approaches to overcome these challenges. For the upcoming year, we request $17,524. If successful, we anticipate returning to request $20,760 to support future proposal development and initiatives begun over the next year.

Belonging in STEM Coordinators - We request stipends to support the work we (K. Cecala & K. Cammack) are doing to coordinate and deliver programming to faculty and students that elevate these conversations and promote the development of a more inclusive STEM community at Sewanee. We will continue to coordinate SciFri programming while actively recruiting and supporting new SciFri faculty leaders, continue to coordinate the DEIBJ in STEM Faculty Learning Community and train/support new FLC faculty leaders, and we will facilitate training and interactions with and among the Belonging in STEM Fellows, Facilitated Study Groups, and the HSTEM student club. We will continue to drive publicity on campus for inclusive teaching and programming in STEM through the "Advocate in STEM" banner and coordinate workshops highlighting student efforts to make recommendations for improvement of the student experience in STEM and faculty work to improve belonging. We will also be responsible for data collection and evaluation and coordination with STEM departments and other campus offices including Student Success and Office of Diversity, Equity, & Inclusion. Finally, we will be responsible for coordinating a larger proposal for external funding that explores innovative, inclusive STEM teaching & learning, in continued conversation with the Director of Corporate & Foundation Relations & the Sponsored Research Office.

Belonging in STEM Faculty Fellows - Beginning in Fall 2023, we led a faculty learning community (FLC) with support from the Center for Teaching that supported a group of 7 faculty members to identify strategies to improve their classes and departmental culture to support greater belonging. We hope to systematize and reward faculty for completing additional training and implementing data-informed approaches to improve student belonging in STEM as one way to begin to shift our culture. We request $2000 per Fellow for a one-year long fellowship from January-December to implement a project to move the institution forward towards attracting, retaining, and supporting underrepresented students in STEM by improving their self efficacy in STEM. We anticipate an application process where we will select 2-3 faculty projects annually.

Faculty Learning Community (FLC) Projects - Our 2023 Faculty Learning Community was funded by the Center for Teaching; this fall, participants completed the NSF-funded MOOC and met weekly for discussion & reflection for six weeks. We request additional funding to support FLC faculty who would like to translate their learning into action by developing DEIBJ-focused changes to their own teaching and/or research spaces, and thus translate their learning into action. We request $500/person for an estimated 4-6 faculty learning community members to develop and share these projects with their departments and the campus community. The Center for Teaching awarded $100/project but quickly hit their funding limit; continued requests to Center for Teaching may also take opportunities away from other potential projects and/or valuable programming, so we seek alternate funding for this important faculty development work.

Faculty HSTEM Mentor(s) - Teaching a new course, such as HSTEM (NOND130), takes considerable time to plan, develop and update. Further, many STEM faculty lack confidence & support implementing DEIBJ-centered content, which impacts their own learning spaces but also their potential willingness to teach HSTEM (NOND130). We request funding for a faculty mentor for new HSTEM (NOND130) instructors ($1000/mentor) to help build a collaborative HSTEM community and provide course materials and ongoing support (e.g., regular meetings to discuss challenges & successes) for faculty who choose to teach HSTEM.

Student HSTEM Fellows. We will establish a vertical mentoring program whereby former HSTEM (NOND130) students are invited to (a) take a leadership role in the Student HSTEM Club and (b) mentor future NOND130 students by engaging in class discussions and helping guide the project-based learning portion of the course. We anticipate 1-2 students per class at a rate of no more than $200/student, to compensate them for their time; we will coordinate with HR to identify an hourly rate, similar to a TA.

These opportunities would be particularly good training for students interested in teaching or leading difficult conversations.

Item	**Year 1**	**Year 2**
Belonging in STEM Coordinators	$5,000	$5,000
Belonging in STEM Faculty Fellows ($2000/fellow x 3 fellows, annually)	$6,000	$6,000
Faculty learning community (FLC) projects ($500/project x 4-6 projects, annually)	$2,000	$3,000
Faculty HSTEM Mentor(s) ($1000/mentor)		$1,000
Student HSTEM Fellows ($200/fellow x 2 fellows)		$400
Benefits (34.8%)	$4,524	$5,360
Total Requested	$17,524	$20,760