Galvanizing Interdisciplinary STEM in Tennessee (GIST)
An Action-Oriented Workshop, June 6—7 2019, East Tennessee State University

High-quality STEM education involves an integrated approach (Johnson, 2013; NRC 2002); weaving together science, technology, engineering, and mathematics improves student achievement (Becker & Park, 2011), reflects the integrated nature of STEM professions (Wang et al., 2011), enables deeper understanding of science (NRC, 2012), and has been observed in successful STEM schools (LaForce et al, 2016). East Tennessee State University (ETSU), Tennessee Technological University (TTU), and University of Tennessee Knoxville (UTK) are proposing a workshop June 6-7, 2019, for galvanizing interdisciplinary STEM course development by injecting such content into disciplinary courses that might often be in our institutions’ general education core.

**K-12 STEM vs. College STEM:** Tennessee adopted a value-added assessment system in 1993, long before other states. In March 2010, using STEM education as a key component of their application, Tennessee (TN) was awarded RttT Phase I funding (USDOE, 2010). With some of the RttT funds, Gov. Bredesen, the TN Dept. of Education (DOE), and the Battelle Memorial Institute launched the TN STEM Innovation Network (TSIN), committed to developing high-quality STEM programming. With the mantra “Kindergarten to jobs,” TSIN aims to better prepare TN students for the STEM workforce by utilizing Regional STEM Innovation Hubs and STEM-designated schools located across TN. Under the direction of the STEM Leadership Council formed in 2014, and in partnership with the TN DOE, the TN STEM Strategic Plan was published in 2016. The plan provides recommendations on full integration of STEM in K-12 education, targeting four priorities to drive the integration of mathematics and science standards with broader STEM-related focuses. In 2017, TN DOE and TSIN collaboratively designed the TN STEM School Designation. Resources were created to define the attributes necessary for a K-12 school to create a comprehensive STEM learning environment. The designation has high standards for integration and collaboration, presenting STEM as integrated, rather than insular disciplines, to prepare students for TN workforce needs. An increasing number of schools are applying for and receiving this designation, and these reforms are changing the way in which TN teachers need to teach STEM.

Ultimately, we seek to transform the STEM experiences of college students, particularly preservice K-8 teachers and non-STEM majors. Across 2-year and 4-year institutions in TN, students currently experience STEM disciplines separately. Their STEM experience is in silos of science, technology, engineering, or mathematics, even though this is very different from how they will be expected to teach – as a parent or classroom teacher. Our partnership seeks to enact the existing national/state recommendations for integrated teaching/learning of interdisciplinary STEM and provide implications for teaching, learning, and leadership in STEM. We aim to embed integrated STEM content into the undergraduate experience by transforming the general education experience for non-STEM majors (including prospective K-8 teachers) by developing course options that could be offered among current general education STEM offerings.

**ETSU STEM Conference:** The ETSU STEM Conference has been held annually since 2007. This year, the proposed GIST project will bring together key leaders in higher education that have influence over STEM course design, for a separate workshop to be held after the ETSU STEM Conference. GIST participants will have an inspiring welcome keynote address before the ETSU STEM Conference, evening GIST meetings during the conference, and a full GIST work day following the conference. Because this
year’s ETSU STEM conference theme is “Integrated STEM Courses in Higher Education,” the conference sessions will serve as informative and inspirational to the workshop goals, which are similar, but more specific for this particular group of leaders. ETSU will still run the ETSU STEM conference as usual for 1.5 days, but serendipitously, **GIST can actually bring faculty together to discuss and plan creation of specific interdisciplinary STEM content that could be embedded into existing courses.**

In December 2017, 13 TBR and UT institutions submitted an ambitious Institutional Transformation Proposal to the NSF IUSE program. **STEM-Powering State of Tennessee Education Majors (STEM²)** was a partnership proposed by these 13 institutions. Reviewers of STEM² were supportive, but stated that we needed to organize smaller groups, plan curricula more carefully, and initially apply for smaller levels of funding. The PIs of this proposal conducted a National Level Intervention workshop at the AAC&U Transforming STEM Higher Education meeting in November 2018. Furthermore, Clark and Godbole organized a paper session at the Joint Mathematics Meetings in January 2019, on the theme of **Integrated STEM Instruction in Undergraduate Mathematics.**

With TSIN and Nuclear Fuel Services funding, we can continue this agenda by indeed bringing theory to practice by running an action oriented workshop on creating **integrative learning in STEM** in Higher Education.

**GIST seeks to:**

- *Propagate change* -- We will bring together faculty with common goals and engage faculty in coordinated interdisciplinary collaborations, and we anticipate that this can lead to changes in teaching practice, in learning experiences, and in institutional policies.
- *Team up* -- We will form teams of faculty members to embed STEM content into courses in the fields of Statistics, Calculus, Math Reasoning, Chemistry, Biology, Physics, Engineering, Geology, and STEM Education.
- *Create coherence* – We will decide on an integrating theme in each field and to begin the work of creating a course outline for a well-identified set of courses.
- *Encourage rich learning* -- We will align the project, at every level, with the principles of active and integrative learning and preparation for meaningful work.
- *Exchange ideas* – Nov. 2018, at an AACU & PKAL meeting, PIs presented “Innovation in Integrated STEM Coursework at Three Tennessee Universities: Past, Present and Future.” To facilitate cross-institutional collaborations and initiate transformation, Research-to-Practice Idea Exchanges (R2PIEs) facilitate transformation and strengthen STEM education in the future.
- *Assess progress* -- We will assess the progress made by the teams.
- *Plan the future* -- We will make a plan for sustaining the project.

**Hoped-for Outcomes:**

- In the long run, open source textbooks for at least five courses;
- In the short run, successful applications for NSF grants;
- In the short run, cementing at least five course development teams;
- In the long run, a proliferation of courses developed by others;
• In the long run, widespread acceptance of integrated STEM courses.

Sustaining the project: We will continue to grow our efforts and agenda in tandem with the work of our curricular groups. In the near future, we will apply for funding via:
• an NSF-IUSE Conference/Workshop Grant for the summer of 2020 that will be larger in scope and reach than both the 2019 STEM conference and GIST workshop;
• individual IUSE grants which are currently being planned or submitted;
• resubmission of a multi-institutional transformation IUSE proposal with a much stronger track record and partnership basis.

Activities: Using best-practice ideologies we will build a state-wide network of academicians who will begin the task of building STEM-intensive versions of courses in the fields of Statistics, Calculus, Math Reasoning, Chemistry, Biology, Physics, Engineering, Geology, and STEM Education. Subject to general guidelines available at the GIST website, all team members will have submitted a Concept Proposal prior to the workshop. Our expectation is that prior to culmination of the workshop, each team have completed
(i) a detailed course outline; and
(ii) a list of items in at least two “chapters”.
In addition, each team should have articulated a timeline for work to be accomplished over the next six months.

References:


