iDigFossils: Engaging K-12 Students in Integrated STEM via 3D Digitization, Printing and Exploration of Fossils

Project Summary

Overview. The goal of this Strategies project is to expand and extend our understanding of integrated STEM learning by designing and testing a model for student engagement using a highly relevant but unexplored educational pathway to K-12 STEM – paleontology. Paleontology, or the scientific study of fossils, is a broad, interdisciplinary field that spans biology and geology, and harnesses the resources provided by advanced technologies and modern statistics. Our team of K-12 teachers, museum professionals, 3D digitization industry experts, and STEM education scholars will design, implement, and study a paleontology-focused and Next Generation Science Standards (NGSS) aligned curriculum that infuses cutting-edge 3D scanning and printing technologies in K-12 STEM. Authentic paleontological data, model-based reasoning, and socio-scientific problem solving will provide rich experiences integrating all 4 STEM disciplines in K-12 science and contribute to cultivating students' interest and identity in STEM. Students will develop scientific habits of mind (e.g., curiosity, informed skepticism), employ science and engineering practices (e.g., developing and using models, analyzing and interpreting data), engage with the concepts that bridge disciplinary boundaries (e.g., patterns, scale, change), and explore relevant disciplinary core ideas in physical and life sciences.

Intellectual Merit. Achieving meaningful integration of STEM in K-12 classrooms is a key challenge discussed by practitioners, researchers, and policy-makers. Teachers have difficulty operationalizing the concept of integrated STEM and designing NGSS-aligned learning experiences that incorporate STEM in meaningful and relevant ways. We address this challenge by proposing to develop an ITEST strategy that promotes K-12 students' engagement in integrated STEM while addressing the three dimensions of the K-12 science education framework (i.e., practices, crosscutting concepts, and core ideas). Specifically, we will a) design and implement a 3D technology-enhanced curriculum that infuses paleontology in K-12 as a true integrated STEM science and contributes to Big Data in Biology (idigbio.org), b) introduce K-12 optimized research software for fossil interpretation and create apps for computational modeling with R, an open source statistics environment, and c) study effective conditions for scaffolding integrated STEM learning and the impact of iDigFossils on cultivating K-12 students' interest and identity in STEM. Our main hypothesis is that engagement in iDigFossils will improve development of student interest in STEM practices and careers.

Broader Impacts. Research, education, and outreach are seamlessly integrated in iDigFossils as we explore and define effective strategies for supporting equitable, highly engaged participation in integrated STEM to nurture student interest and identity in STEM. While solving paleontology-focused problems, K-12 students will be developing deep understandings of evolution, biodiversity, and climate change. The project will democratize access to fossils by contributing high-fidelity 3D models to Integrated Digitized Biocollections (idigbio.org), the National Resource for Advancing Digitization of Biodiversity Collections funded by the NSF. Our strategy will impact at least 45 teachers and over 900 students, many of whom are from groups currently underrepresented in STEM (Latinos, African Americans, females). Harnessing the intellectual power and organizational resources of a flagship research university, a leading natural history museum, public K-12 schools, industry partners, and the national specimen digitization project, our strategy will generate new opportunities to engage K-12 students in integrated STEM. The outcomes of iDigFossils include:

- A transferable model for equitable engagement in integrated STEM via 3D technology-enhanced paleontology explorations and socio-scientific model-based reasoning;
- An online library of customizable open-source learning activities and 3D models that help integrate STEM in the K-12 classroom and cultivate student interest in integrated STEM practices and careers;
- K-12 optimized interactive applications for exploring, enhancing, and studying 3D models and for computational modeling with R, an open source statistics environment;
- Widely disseminated research and professional development resources on the infusion of paleontology and 3D scanning and printing to address the K-12 Science Education Framework and NGSS; and
- Increased engagement of K-12 students and teachers in integrated STEM that contributes to building the critically needed STEM education pipeline and workforce ready for the challenges of the 21st century.