

## PROJECT SUMMARY

With the proliferation of learning objects (LOs) online, both teachers and students are often frustrated in locating those that will meet their specific instructional and learning needs. A key component of this problem is that no currently available learning objects are based on learning research, contain embedded guidance on how they should be used, and adhere to the Shareable Content Object Reference Model (SCORM) standard. Thus, the long-range goal of the project research team is to augment LOs with **empirical usage intelligence**—how an LO should be used, how it has been used, and how it has impacted instruction and learning—that will result in radical improvements in learning and instruction. With this embedded intelligence, learners and teachers will be able to identify the LOs that match their needs, educational and experiential backgrounds, and mode of learning or teaching. Learning management systems will also be able to more effectively sequence learning objects to build courses. To take a significant step toward this long-range goal, this project will be guided by an integrated and multidisciplinary approach in pursuit of the following specific technology and learning goals:

**Technology Goal 1:** Create an *Intelligent Learning Object Guide (iLOG)* that tracks, diagnoses, and tags the empirical usage intelligence of learning objects.

**Technology Goal 2:** Revise and convert the online course materials for an undergraduate introductory CS course (CS1, already developed at the University of Nebraska-Lincoln [UNL]) into learning objects.

**Learning Goal 1:** Identify the salient learner attributes and content/pedagogical characteristics that can be empirically tracked to impact learning.

**Learning Goal 2:** Measure the impact of active learning and elaborative feedback on student learning with learning objects.

**Intellectual Merit** This proposed project will advance the existing knowledge base for both learning technology and educational research. In terms of technology, we will develop an intelligent system that can track, diagnose, and tag how an LO has been used, by taking into account learner attributes, and content/pedagogical characteristics. The diagnosis component will integrate domain heuristics, statistical approaches, and data mining to identify and discovery anomaly-diagnosis patterns to update LO metadata accurately. The assessment and evaluation will determine how each LO metadata parameter impacts or predicts student learning and, in turn, identify important salient features. We will also incorporate active learning and elaborative feedback to enrich LO-learner interaction and evaluate their impact on student learning. Our proposed activities integrate symbiotically computer science and learning research advances in the identification and evaluation of learner and learning object profiles at two levels: empirical usage intelligence (the *data* that describe how an LO should be and has been used) and iLOG (the *process* that updates the empirical usage intelligence).

**Broader Impacts** Our project will extend the cycle of knowledge discovery and production and improvement of practice in undergraduate STEM education by contributing in three key areas: (a) enhancing the SCORM metadata standard to describe with high precision how an LO has been used, (b) incorporating and evaluating active learning and elaborative feedback in LOs, and (c) conducting research on adaptive undergraduate STEM teaching and learning. The expected results of the technology and learning research activities of this project will provide a better understanding of (1) how best to teach introductory CS courses with multiple entry points or customizations using different combinations of LOs and (2) how students learn from this dynamic form of instruction. Our research has the potential to provide the pathway for independent learning of complex subject matter and provide flexibility in terms of anytime, anywhere instruction. *Learning objects with embedded empirical usage intelligence* can fundamentally revolutionize how to best utilize advanced technologies in the design and delivery of online instruction, how to best support the selection and use of such instruction among individual learners, and how to best support the experimentation, evaluation, and adoption of LOs in courses for instructors. This can, in the long term, to alleviate the workforce shortage in the areas of computer science and information technology in the U.S.