

## The Simon Initiative Learning Engineering Ecosystem

Making the next great leap forward in improving education will require an approach that combines what we know about how learning works with learning data and advances in information technology to demonstrably improve student learning productivity and outcomes. As part of President Subra Suresh's vision for **The Simon Initiative**<sup>1</sup>, Carnegie Mellon University proposes a **Learning Engineering Ecosystem** that fosters and leverages *a multi-institution large-scale collaboration* and *openly releases our most effective learning engineering tools* to the world. To this end, Carnegie Mellon adds its expertise and software tools to a growing movement among colleges and universities seeking to advance our understanding of human learning.

Learning engineering bridges gaps between theory and practice, while improving both. CMU has pioneered this approach which emphasizes: 1) building and leveraging cognitive models of expertise to inform the design of effective student-centered instructional materials, 2) collecting rich data on student interactions and learning outcomes, 3) data analysis via state-of-the-art machine learning and analytic methods, 4) data-informed iterative improvement of the instructional materials, and 5) leveraging these assets to drive fresh insights in learning science.

The demand for learning engineering continues to grow, but a significant barrier to adoption is a lack of tools to support using this approach. The proprietary and isolated nature of existing tool development efforts and resulting products, limits our institutions' abilities to adopt, integrate, improve, and expand what tools are available, contributing to an inefficient cycle of development silos and reinvention. We have heard a strong desire expressed (from within CMU and from our partner institutions) for an improved open source toolset that would address these issues and accelerate community-based efforts to leverage CMU's work in learning science and engineering.

Through the Open Learning Initiative (OLI)<sup>2</sup>, the Pittsburgh Science of Learning Center (PSLC)<sup>3</sup>, and other recent efforts, CMU has developed a technology suite that begins to meet this demand; elements of which are already in use by many partners who are anxious to see continued access to and improvement of the tools. These partners would commit to these tools and support ongoing efforts through an open community-based model. Such a model would be transformational, laying the groundwork for a well-integrated ecosystem of learning engineering technologies to support the next great leap forward in educational improvement while also providing infrastructure to sustain and advance the work.

To facilitate this effort, **The Simon Initiative** will *openly release* its most effective learning engineering tools as a foundation for a *large-scale, multi-institutional, open-source collaboration*. Together these tools constitute a suite of applications and services that support the full range of the Simon approach – designing and developing authentic learning experiences; creating, validating and improving learning and cognitive models; delivering learning experiences; capturing, sharing, and analyzing learning data – in a way that integrates research and practice. Such an ecosystem also lays the foundation for developing an authentic community of effective open content: a community supported by scaffolded, platform-agnostic authoring tools that embed best-practices; a community that can easily re-use and modify existing, proven resources; a community that can compare efficacy of refined materials and approaches.

<sup>1</sup> <http://www.cmu.edu/simon/> | <sup>2</sup> <http://oli.cmu.edu/> | <sup>3</sup> <http://www.learnlab.org/>

The tools to support this consortium are a loosely integrated set of technologies that together exemplify and encompass the Simon Learning Engineering approach:

- **Simon DataLab Technologies:** Built on the foundation of the world's largest repository of learner interaction data—PSLC DataShop—the Simon DataLab provides the premier infrastructure to collect and store thousands of high quality data sets, accumulate the best analytic methods, and create a large-scale research community to improve education through empirical research.
- **OLI Platform & Content:** Regarded as one of the world's most effective open education projects, OLI's course development and delivery platform is built upon learning science principles and designed to facilitate research, exhaustive data capture, and continuous improvement; with course materials made available under Creative Commons licenses.
- **CTAT:** The Cognitive Tutor Authoring Toolkit (CTAT) provides the most effective and direct way to develop intelligent tutoring systems of varying degrees of complexity, drawing on decades of CMU research. CTAT tutors integrate with *DataShop* and the *OLI Platform*.
- **SimStudent:** SimStudent reduces the effort and expertise necessary for creating tutor models by providing a simulated student that authors can 'teach'; from these interactions, the software can derive effective models.
- **AutoLab:** A culmination of years of research and application in CMU's School of Computer Science, Autolab provides automated analysis and feedback of student software artifacts.
- **DANCE Discourse and Collaboration Tools:** A suite of tools that apply machine learning and natural language processing techniques, DANCE analyzes and engages with language, supporting authentic learning experiences ranging from discussions to essays.
- **TETRAD:** Causal inference exploration software with exceptional workflow tools.
- **IDEA:** An integrated design and authoring environment that embeds learning data into the development view for data-driven, iterative improvement.

Together these tools represent an investment of over *30 million dollars, 1.3 million lines of code*, years of research, and an unprecedented application of pedagogical and learning science expertise that will be opened to the world, establishing a foundation for the next generation of learning engineering tools and practices.

We seek to establish and support an open-source community that involves learning scientists, learning engineers, faculty, educators, and technologists in a collective effort to share strategies, tools, and data to support effective learning.

Openly releasing our existing learning engineering suite as a foundation for developing a larger community represents a key step in capitalizing on existing work, increasing impact and setting the stage for our future discoveries and innovations. This ecosystem of well-integrated technologies is more powerful than the individual components and will drive a virtuous cycle of interaction between learning research and teaching practice that will improve higher education.

*A broader announcement will soon come from The Simon Initiative about modes of access to the open source software and the development of an open source community. To stay informed, contact us: [simon-initiative@andrew.cmu.edu](mailto:simon-initiative@andrew.cmu.edu)*