

Precision Education: The Virtual Learning Lab

Topic: Education Research and Development Center on Virtual Learning

The University of Florida, The University of Notre Dame, Illustrative Mathematics, and Study Edge will bring together expertise in informatics, mathematics education, and teacher professional development to launch the emerging field of *precision education*, in which data from prior users is to generate instructional sequences to optimize individual students' learning outcomes. Precision education is now becoming possible due to the availability of large data sets accumulated as students work with technology-based systems, combined with the application of data mining and powerful machine learning methods that can identify optimal sequences for individual students. The Lab's activities will be organized around the goal of improving the impact of *Algebra Nation*: a free online learning platform for students and teachers designed to promote mastery of basic algebra. Launched in 2013, Algebra Nation is now in use across Florida, with a reach of over 200,000 student users, and is expanding into other states.

The Virtual Learning Lab will conduct a *focused program of research* to learn whether *precision education* in the context of Algebra Nation can improve students' ability to pass an end-of-course exam. The proposed research will specifically address the grand challenge of *improving the performance of low-achieving students* through investigations into personalizing instruction via learning analytics; developing sensor-free estimates of engagement during learning; and designing professional development to help teachers use learning analytics to differentiate their instruction. A pilot study with a quasi-experimental design will be followed by an Efficacy Study in using a randomized control trial (RCT) design in which the personalized version of Algebra Nation is compared to the original non-personalized version. Studies will be conducted with students enrolled in algebra (typically, Grade 9), with sensor-free engagement estimates and performance on the end-of-course exams as primary outcome measures. The project results will serve as a national model for a new approach to developing online systems that can use prior student data to optimize, update and refine the instruction provided to current users.

In addition to the focused program of research on Algebra Nation, the Virtual Learning Lab will serve as a national hub for sharing findings and producing guidelines regarding the design of personalization of virtual learning systems through the use of learning analytics and accompanying professional development for teachers. Activities will include summer workshops for students, an annual analytics competition, collaborative sessions at key conferences, and supplemental studies in which researchers can collaborate with the team on projects involving shared data and analytic approaches. A communication plan includes the use of scholarly outlets, as well as traditional news media and social media to reach researchers, practitioners, policy-makers and the public. Within five years, the Lab's work will lead to a significantly extended knowledge base regarding the promise of precision education to improve students' learning outcomes through data-derived personalization of instruction.

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