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NEXT GENERATION
LEARNING CHALLENGES

Innovations Designed for Deeper Learning in Higher Education

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Key Takeaways

- Seven institutions received $1.7 million in funding from the Next Generation Learning Challenges (NGLC) Building Blocks for College Completion grant program to scale innovations designed to promote deeper learning and student engagement in higher education to other institutions. The group reached 9,955 students at 135 institutions during the grant term.
- Lacking a common definition of "deeper learning," the grantees adopted different technology-enabled educational innovations in their efforts to help students achieve it, including supplementing existing courses, supporting the adoption of blended learning, and completely redesigning a course (the most successful approach).
- Given the lack of a definition, grantees struggled to find good measures of deeper learning and developed a range of proxy indicators to understand the effects of their innovations on students.
- Grantee projects covered three to five aspects of the Hewlett Foundation's definition of deeper learning (used for this report but not by grantees), with all supporting two aspects, mastery of core academic content and self-directed learning.
- When implementing the innovations, a majority of instructors assessed deeper learning and used student data to inform instruction, but less than half used project-based learning, a potential missed opportunity in postsecondary settings.
- Only one grantee, U-Pace, had statistically significant effects (more positive outcomes for its students as compared to the control group). U-Pace was also the only grantee that made substantial holistic changes in faculty practices and classroom pedagogy.
- Results suggest that students need support to transition to the more active role in their own learning that deeper learning demands and that faculty need support, training, and time to create, implement, and sustain reforms that change student learning.
- The results also mirror the project evaluator's findings across all 29 of the NGLC-funded Building Blocks projects; innovations involving supplemental resources were less successful than whole course redesign efforts. Fundamental, comprehensive redesign occurring over more than one academic term appears to promise the best outcomes for deeper learning.

The Potential: What Is Deeper Learning?

Within higher education, there is an increasing focus on what and how students learn; historically, these issues have rarely been discussed in policy and funding circles, given the deep roots of academic freedom. Starting in the 1990s, groups such as the National Center for Public Policy and Higher Education, through its Measuring Up series, and other entities began to shine a light on student learning in postsecondary education—making clear that we knew surprisingly little about what students learn and retain. Currently, with the focus on 21st-century knowledge and skills, workforce readiness, low completion rates in developmental education and core gateway classes, and low rates of certificate and degree completion, there is an increased emphasis on helping postsecondary institutions examine, define, and improve student learning.

In addition, there is growing interest in the nonacademic knowledge and skills required to succeed in all academic areas. Habits of mind (such as persistence and self-efficacy) and key cognitive strategies (such as the ability to hypothesize, analyze, strategize, and evaluate) are critically important attributes to foster throughout students' K–12 and postsecondary education pathways. In the classroom, deeper learning is the result of students' learning core knowledge along with the utilization of nonacademic dispositions. It focuses on the interaction between nonacademic knowledge and skills and the acquisition of academic content. For its deeper learning grant making, Next Generation Learning Challenges has adopted the William and Flora Hewlett Foundation definition of deeper learning (see also the sidebar).

Deeper Learning: Knowledge, Skills, and Beliefs

Mastery of Core Academic Content: Students build their academic foundation in subjects such as the humanities, social sciences, math, and science. They understand key principles and procedures, recall facts, use the correct language, and draw on their knowledge to complete new tasks.

Critical Thinking and Problem Solving: Students think critically, analytically, and creatively. They know how to find, evaluate, and synthesize information to construct arguments. They can design their own solutions to complex problems.

Collaboration: Collaborative students work well in teams. They communicate and understand multiple points of view and they know how to cooperate to achieve a shared goal.

Effective Communication: Students communicate effectively in writing and in oral presentations. They structure information in meaningful ways, listen to and give feedback, and construct messages for particular audiences.

Self-Directed Learning: Students develop an ability to direct their own learning. They set goals, monitor their own progress, and reflect on their own strengths and areas for improvement. They learn to see setbacks as opportunities for feedback and growth. Students who learn through self-direction are more adaptive than their peers.

An "Academic Mind-Set:" Students with an academic mind-set have a strong belief in themselves. They trust their own abilities and believe their hard work will pay off, so they persist to overcome obstacles. They also learn from and support each other. They see the relevance of their schoolwork to the real world and their own future success.

Source: The William and Flora Hewlett Foundation, What Is Deeper Learning?

Deeper learning does not have a one-size-fits-all approach or model. At its core, deeper learning is about providing opportunities for students so they can become self-motivated, competent learners (and view themselves as such) who are able to retain and apply knowledge in a variety of contexts, work effectively with others, and exhibit the other dimensions of learning described here. Students learn academic knowledge while using effective skills and behaviors, with habits of mind and key cognitive strategies supporting students' abilities to learn deeply. This mutually reinforcing relationship is at the core of sound teaching and learning, but it has not been explicitly encouraged through large-scale policy and practice in recent years. Many of these ideas harken back to American education reformer John Dewey's philosophies on engagement, interaction, communication, experiential education, problem-based learning, and going beyond academic content to reach one's full potential (for more, see Dewey's profile in the PBS series *Only a Teacher*).

Classroom innovations that leverage technology have the potential to support deeper learning in a number of ways. For example, if students learn core content outside the classroom, through podcasts or online textbooks, that can allow time for deeper forms of engagement within the classroom, such as group projects and other forms of applying knowledge. This flipped-classroom approach is particularly helpful in large, lecture-based classes. Other classroom innovations incorporate self-paced learning; by providing students with digital course materials, instructors allow individual students to move at the speed that works best for them, engage more deeply with material they have mastered, and spend additional time on material that is new or particularly challenging. Furthermore, classroom innovations that use real-time, instantaneous feedback from digital content can help students address their learning gaps and can also inform instructors' decisions about the use of instructional time.

This report presents information about the development, adoption, and scaling of technology-enabled innovations created by seven postsecondary institutions in NGLC's Building Blocks for College Completion grant program. The innovations were designed to promote and support deeper learning and engagement. This report is geared toward helping those who are interested in improving deeper learning and engagement through educational innovations—and often classroom-based innovations—that incorporate technology.

Information Sources

Data for this report come from grantees' applications and other materials submitted to NGLC. In addition, interviews were conducted with the following representatives from three of the innovations, chosen because they represent varied approaches: Cynthia Powell from Abilene Christian University's MEIBL, Jennifer Spohrer from Bryn Mawr College's blended learning STEM initiative, and Diane Reddy from the University of Wisconsin-Milwaukee's U-Pace. Another source is the unpublished independent evaluation of grant projects conducted by SRI International and commissioned by the Bill & Melinda Gates Foundation.

NGLC's Deeper Learning Challenge

The first wave of NGLC grants focused on improving postsecondary completion rates by addressing the effectiveness and quality of the courses that most often are barriers for low-income college students. The NGLC Building Blocks for College Completion RFP, which was released in October 2010, stated that the main objectives were to improve "course completion, persistence, and college completion through sustainable, broad-scale, technology-enabled product, project, or service-based solutions." The main goal of the grant program was to scale innovations working at one postsecondary institution to additional institutions. In addition, the RFP included the following four broad areas of focus, or challenge areas:

- Blended learning models combining face-to-face and online learning activities
- **Interactive applications that enhance student engagement and promote deeper learning**
- Learning analytics that make current learning performance information available to learners, instructors, and advisors
- High-quality open core courseware for high-enrollment developmental and introductory courses

There were over 600 applicants (261 in the deeper learning category), of which 29 were funded. Although many of the 29 grantees included deeper learning in their work, this report provides information on the 7 grantees that applied directly to the deeper learning challenge area. Unless otherwise cited, all of the outcomes data in this report are from findings in the unpublished *Next Generation Learning Challenges Wave I: Final Evaluation Report* produced by SRI International (SRI), the evaluator for Building Blocks for College Completion.

This report briefly describes each innovation and related available evidence, explains how the Hewlett Foundation dimensions of deeper learning are addressed by the collection of projects, discusses challenges encountered by the grantees, summarizes issues related to implementation and scaling, and synthesizes the learnings.

NGLC-Funded Innovations

Table 1 provides the institution's NGLC website and objective/description for each innovation. The goals of the innovations vary from allowing students to learn core content outside class to free up class time for a deeper level of communication and engagement to an online simulation program that promotes experimentation with different pedagogical techniques. These seven grantees were selected by the NGLC Executive Committee using criteria that focused on relevance to deeper learning, boldness of innovation, early signals of effectiveness, capacity to execute successfully, and the perceived promise of the applicants' scale-up plan.

Table 1. The deeper learning projects

Innovation	Objective/Description
MEIBL **Abilene Christian University**	To make inquiry-based science laboratory activities more accessible to students by providing support at the moment of need on mobile devices via faculty-produced video and other visual resources
IPAL **Eckerd College**	Polling tool to promote student engagement
U-Pace **University of Wisconsin-Milwaukee**	Integrates academics and supports so that students can receive high touch interventions
BioBook **Wake Forest University**	Online biology book that presents small chunks of material in nonlinear ways; students can learn the topics in any order they choose
simSchool **Association for the Advancement of Computing in Education**	Classroom simulation for students in teacher education programs; students experiment with different teaching approaches and learn the possible effects on interaction and learning
Wayang Outpost **University of Massachusetts, Amherst**	An online adaptive tutor that changes its responses in order to meet a student's learning needs
Blended Learning in STEM in Liberal Arts Institutions **Bryn Mawr College**	Determine whether blended learning can improve learning outcomes, persistence, and postsecondary completion at liberal arts colleges, particularly in STEM fields

Deeper Learning Approaches

Each grantee devised different innovations in its attempt to achieve deeper learning. Five of the seven grantees (AACE, Abilene Christian, Eckerd, UMass, and Wake Forest) developed innovations to supplement existing courses, usually with the intent of encouraging a more student-centered instructional approach or introducing a new type of pedagogy. As the SRI report found, "Some of these resources were subject specific (such as Wayang Outpost for math or simSchool for teacher training), and some were more general (such as IPAL, which supports in-class polling capabilities for a variety of course subjects). Typically, adopting instructors and students could use these resources as they saw fit to enhance their existing courses." Overall, across all of the Building Blocks grantees, based on SRI's findings, innovations involving supplemental resources were less successful than whole course redesign efforts; the latter were more prescriptive about instructional approaches.

Abilene Christian University

ACU is a small Christian university that has encouraged its students to use mobile devices for several years. ACU requires that all entering students own an iPad. ACU's MEIBL (mobile-enhanced inquiry-based learning) was developed by a chemistry professor to allow students to watch faculty-produced videos on their computers, smartphones, and other technologies to help them during lab. The videos replace some of the short introductory lectures at the beginning of a lab period, but more importantly provide support for the students during lab as an "always available tutor" during the lab activity. MEIBL requires that faculty flip the class; prior to class, students explore a lab activity, review instructional podcasts, and complete a writing exercise related to the preclass work.

Watching the videos helps students prepare more effectively before they come to class. An advantage of the MEIBL approach is the availability of the video resources during lab, so when students are beginning to work with a new procedure, technique, or piece of equipment, they can pull up the explanation video showing the exact piece of equipment, procedure, or technique they will use. They watch the video side-by-side with their experiment in the lab to see precisely what they should be doing. In class, students work in teams to investigate questions, develop ideas and hypotheses, test hypotheses, generate and analyze empirically based information, and discuss findings. An assumption behind MEIBL is that it will lead to greater student engagement, which, in turn, will lead to better understanding of concepts, improved retention of learned material, and better application of information in a variety of contexts.

Evidence. ACU enrolls approximately 200 students in MEIBL courses (General Chemistry I and II). California University of Pennsylvania and Del Mar College in Texas are currently using MEIBL, enrolling approximately 600 and 24 students, respectively, in MEIBL-enabled science courses. During the grant period, MEIBL reached 375 students (180 proposed) at the three institutions. In terms of student outcomes, 93% completed the course, 81% demonstrated subject matter mastery, 60% demonstrated evidence of deeper learning, and 91% persisted to the next academic term.

Furthermore, the NGLC RFP encouraged prospective grantees to define deeper learning for themselves, in their own contexts and based on their own needs. For example, Bryn Mawr staff and faculty used the concept of intrinsic versus extrinsic motivation as the foundation for their work to develop blended courses, emphasizing mastery of concepts and skills in order to foster intrinsically motivated learning, which tends to correlate with deeper learning (see the sidebar on SOLO).

This report examines the innovations using Hewlett Foundation's definition of deeper learning as a reference point (see the sidebar), even though it did not function as such for the grantees. The specific components, however, map fairly well to many of the grantees' innovations, as detailed in table 2 and exemplified in this list:

- *Mastery of core content* can be seen in BioBook since it is essentially a biology textbook.
- *Critical thinking and problem solving* are enabled by applications such as simSchool, which allows students to practice complex skills online so they can engage in higher-order thinking required for more challenging activities during class time. Engagement and problem solving are foci of IPAL via its in-class polling.
- *Collaboration* can be supported by technologies that open up the space for that to occur during class (MEIBL) and those that are a platform for group exercises (IPAL).
- *Effective communication* is exemplified by simSchool, which focuses students' attention on the interactions between an avatar teacher and a group of students.
- *Self-directed learning* is a key aspect of Wayang Outpost, since its online tutoring and information is calibrated with what each student knows in that moment in time.
- *The development of an academic mind-set* is supported through U-Pace's Amplified Assistance and through Wayang Outpost's interactive tutoring platform.

NGLC expected the classroom innovations it funded to contribute to deeper learning through increased engagement, but not necessarily to touch each dimension of deeper learning as described in the Hewlett Foundation definition. Examining the innovations according to each dimension of the definition can help illuminate the strengths and weaknesses of the different tools and strategies the grantees developed, relative to the outcomes they were seeking.

While there is great variation in how the seven grantees approached deeper learning, there are some clear overlaps. Most, for example, view deeper learning as going beyond learning a skill, or some particular piece of knowledge, and applying it intensively. Mastery of core academic content (six grantees) and self-directed learning (all grantees) are the two areas that most or all grantees focused on (see table 2). The popularity of these two dimensions in particular is relatively intuitive because (1) if students learn core content on their own time through a technology tool, it creates more time for more engaged in-person learning with groups of peers or through instructor-led activities, and (2) students can make choices about what and how they learn—that is, direct their own learning—through technology such as an online tutoring program or self-paced curricula. In terms of mastery of core academic content, this was reflected, for example, by the development of BioBook, the supplemental online biology textbook, or Bryn Mawr's use of online, interactive tutorials to emphasize mastery in blended STEM courses. The self-directed learning component can be seen, for example, in U-Pace's mastery-based model and in IPAL, where students take initiative to fill in their knowledge gaps highlighted by the polling.

The relationships between each grant and the components of the definition of deeper learning are detailed in table 2.

The SOLO Taxonomy

MEIBL developers defined deeper learning by using a taxonomy called SOLO that provides a process for faculty to assess students' work on the basis of its overall quality rather than on "bits and pieces" of what students got right on a test. It provides information for instructors to support student learning from the memorization of basic facts to the use of extended abstract understanding.

Eckerd College

Eckerd College developed IPAL (In-class Polling for All Learners) as a free, open-source polling tool with ready-to-use, peer-reviewed questions. An IPAL app also turns students' phones into clickers. Students can use any computer, smartphone, or other web-enabled device to respond to the polling questions. After polling the class, the instructor can view and display responses arrayed in graphic forms. Analyses of student responses can allow for early identification of students who are struggling in class, which can lead to additional supports and increased retention. In addition to helping students persist, another objective of IPAL is to help students become more engaged and active learners.

Evidence. In terms of student outcomes, 93% completed the course, 83% demonstrated subject matter mastery, 83% demonstrated evidence of deeper learning, and 96% persisted to the next academic term. In terms of scale, Eckerd did not meet its goals for student reach (4,000 proposed, 531 reached) or institutional reach (50 proposed, 5 reached).

Table 2. Mapping grantees' projects to Hewlett Foundation's components of deeper learning*

	MEIBL	IPAL	U-Pace	BioBook	simSchool	UMass	Bryn Mawr
Mastery of Core Academic Content	Tech-provided	Tech-provided	Tech-provided	Tech-provided		Tech-provided	Tech-provided
Critical Thinking and Problem Solving	Tech-enabled	Tech-enabled	Tech-provided		Tech-enabled	Tech-provided	Tech-enabled
Collaboration	Tech-enabled	Tech-enabled		Tech-provided	Tech-provided		Tech-enabled
Effective Communication	Tech-enabled				Tech-provided		
Self-Directed Learning	Tech-enabled	Tech-provided	Tech-provided	Tech-provided	Tech-provided	Tech-provided	Tech-provided
Development of Academic Mind-Set			Tech-enabled (Amplified) Assistance)			Tech-provided	

* *"Tech-provided" indicates that the dimension of deeper learning is intended to be achieved through the use of the technology tool alone. "Tech-enabled" indicates that the dimension of deeper learning may be achieved through the instructional strategies that the use of the technology tool makes possible (for example, project- or inquiry-based learning opportunities supported by the online delivery of core academic content).*

As displayed in table 2, the grantees' projects cover three to five aspects of deeper learning each, whether directly through the technology or enabled through another component of the innovation. For example, while almost all of the grantees intend for core content to be learned through the use of the technology tool alone (tech-provided), the majority that focus on critical thinking and problem-solving intend for the tool to make learning those skills happen through the use of other instructional strategies that the technology makes possible (tech-enabled).

Challenges to Supporting Deeper Learning through Technology

Interviewees cited the following areas as major challenges.

Measurement difficulties. *Grantees struggled to find good measures of deeper learning and developed a range of proxy measures to understand the effects of their innovations on students.* Much of what the grantees wished to learn could not be measured by a standardized test. As an interviewee from Bryn Mawr stated, "The hardest thing for us was figuring out how to measure deeper learning. There is not a lot to go on in the literature." They decided to use course grades as a proxy, supplemented with qualitative analysis of attitudinal survey data from students and faculty to determine whether respondents chose language suggesting blended learning correlated with deep learning—for example, students discussing impact on their learning in terms of mastery rather than grades. MEIBL staff conducted student surveys, administered writing assessments, used end-of-semester lab reports, and asked students to write reflections about their learning. They found that students learned more content; could express what they learned more deeply; and believed that MEIBL enhanced their confidence, ability to learn independently, engagement, and overall experience in their labs. U-Pace developed its own quizzes with a high bar, and a high level of support, for students to pass in order to indicate mastery. U-Pace staff also used a critical thinking rubric to assess students' understandings.

Inadequate capacity and support. *Faculty adopting the grantees' innovations required both technological and pedagogical support as well as time, which weren't always available at adopting institutions.* The technologies, and the support available to adopt and learn about new technologies, vary greatly across institutions. As one interviewee noted, "It can be exhausting if you're doing it [creating and implementing a new technology] on your own. It can be time-consuming." In addition, it is likely not possible for instructors to redesign every course they teach in one year. Instructors need support to learn what is achievable in one year, given that instructors cannot stop teaching, conducting research, or contributing to service on campus in order to redesign their courses.

The Association for the Advancement of Computing in Education

AACE co-sponsored the scale-up proposal from simSchool as a classroom simulation for graduate students in teacher education programs. By using simSchool, students can examine classroom management styles, explore instructional strategies, and practice relationship-building techniques with simulated students. Students use game-like tools and interactive features in virtual classrooms to role-play teaching and interacting with a diverse group of simulated students (diverse in terms of factors such as age, achievement, race/ethnicity, personalities, language proficiency, special needs, and learning styles). The developers hope that the act of simulation engages students at deeper levels than do traditional pedagogical methods. Since simSchool is entirely web based, it does not need to integrate with any other kind of technology.

Evidence. In terms of scale, AACE exceeded its goals for both student reach (4,000 proposed, 7,508 reached) and institutional reach (7 proposed, 116 reached). Outcome data concerning undergraduate success were not provided in SRI's report; however, several outcomes related to teacher education have been reported in the literature including increased knowledge of teaching, increased self-efficacy as a teacher, and increased positive attitudes about using game-based methods in teaching.[1]

1. Knezek, G., Christensen, R., Tyler-Wood, T., Fisser, P., & Gibson, D. (2012). "simSchool: Research Outcomes from Simulated Classrooms," in Proceedings of the Society for Information Technology & Teacher Education International Conference 2012, ed. Resta P. (Chesapeake, VA: AACE).

> ***"The innovations were used predominantly by instructors who taught science and education courses, although the innovations were also used in social science and math courses."***

One interviewee reported that faculty participating in the pilot were often discouraged to discover that commercial "off-the-shelf" courseware packages in their field were not compatible with deeper learning, or that open educational resources (OER, or free resources that are licensed to be used, remixed, and repurposed by others) were often technically out-of-date, lacked mechanisms for enabling faculty to collect and view student learning data for faculty, and rarely came with tech support. Some faculty members responded by creating their own materials, but this required even more time and vast skill building—as one economics professor put it, "I'm a teacher, not a software designer. I want to focus on my strengths."

Uneven faculty engagement. *Grantees have found it hard to engage new faculty members.* When these types of grant opportunities arise, faculty who feel comfortable with new technologies, and with experimentation in this arena, become involved. Reaching faculty who do not volunteer for these opportunities is very difficult for a variety of reasons, including discomfort or lack of experience with new technologies, a lack of support to troubleshoot glitches, and philosophical beliefs about technology in the classroom. The last issue might be particularly relevant for deeper learning because it connects so completely with pedagogy, with each instructor controlling instructional philosophies and techniques. There is no formula or particular pedagogy behind deeper learning.

SRI surveyed instructors and found that their motivations to experiment with the grantees' innovations were generally student-centered. For example, 33 stated that they volunteered to use the tech-enabled innovation because they were interested in exploring online teaching and learning (compared with 12 who indicated that they did not have such an interest). Twenty-eight stated that their motivation was to have greater student engagement (compared with 17 who were not motivated by that issue). Thirty-three stated that they expected that their

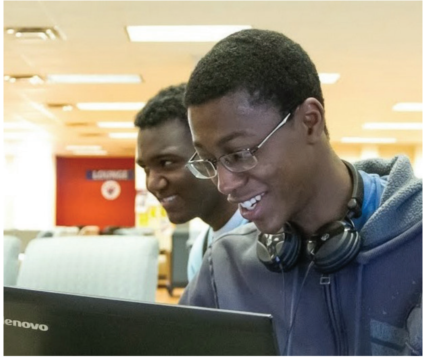
Wake Forest University

Science faculty members at Wake Forest examined data about failure and drop-out rates in introductory science courses and decided to develop an iPad application to improve student success in biology. The application evolved into an online textbook, BioBook. Working with technology partners at Odigia, they created BioBook within a Moodle-compatible platform that students can access from any web-enabled device. BioBook is structured with small chunks of material presented in nonlinear ways, so students can explore topics in any order they choose. "Personal Progress Maps" are embedded throughout BioBook and track the modules students visit and complete, the amount of time spent on them, questions they pose electronically, assessments completed, and the time spent on BioBook tasks. Instructors can use the information from the maps to monitor students' progress. The theory of action is that collaborative interactions and nonlinear material combine to increase student learning and engagement. The developers hope the maps will make students more accountable and engaged by allowing them to investigate the materials they need.[1]

Evidence. In terms of student outcomes, 92% completed the course, 70% demonstrated subject matter mastery, 13% demonstrated evidence of deeper learning, and 85% persisted to the next academic term. In terms of scale, during the grant period, Wake Forest did not achieve its goal for student reach (4,000 proposed, 504 reached) but did meet its goal of reaching four institutions.

1. See Brett Eaton, "BioBook–eText Evolved," Wake Forest University News Center, April 8, 2011.

students would learn more with the innovation (12 did not believe that to be the case). No faculty members thought that using the innovation would be easier than current practice, and almost no faculty thought that the innovation would create a more flexible schedule (one) or be attractive on a résumé (two).



Variable instructional approaches. *Grantees found that some faculty members implementing their innovation were faithful to the classroom innovation's pedagogical model, while others were not, even when training was provided.* As one interviewee explained it, "A lot of what we do in the classroom is personality dependent." The interviewee had trained several faculty members in inquiry-based curricula and related pedagogy. During classroom observations, she found that while some faculty members were faithful to the model, one was not. She provided additional training for that faculty member, but could not provide enough, given that the grant was just for one year. Also, she questioned the utility of trying to assess deeper leaning based on one year-long effort. An interviewee who led a cross-campus innovation noted, "People across campuses did their own thing. Some were similar to what our faculty was doing and some were not."

Instructors' Perceptions of the Innovations

From a survey of instructors using the seven grantees' innovations in their courses, 70% reported that they assessed deeper learning in all of their courses/sections; deeper learning was defined on the survey as content mastery, problem solving, critical thinking, and/or teamwork. A majority of the instructors using the innovations reported that they used the following features: assessing deeper learning (87%), using student data to inform future instruction (79%), and using blended online and classroom-based activities (60%). Most of the instructors surveyed were satisfied with the innovation (25% were highly satisfied and 55% were moderately satisfied), but 9% were moderately dissatisfied; 21% reported their students were highly satisfied with the innovation, 40% reported their students were moderately satisfied, 9% reported their students were moderately dissatisfied, and 6% reported their students were highly dissatisfied. The survey was conducted by SRI International.

Implementation and Scaling

As mentioned earlier, the goal of the grant program was to scale innovations working at one postsecondary institution to additional institutions. In general, SRI's researchers found that almost all of the 29 innovations funded by NGLC were not ready to scale to other institutions at the start of their grant period. Consequently, many of the implementation experiences the grantees encountered were not related to deeper learning. Most difficulties centered on technology compatibility, collaboration, and the development of cross-institutional culture—issues that could be problematic for any attempt to scale a tech-based initiative across institutions.

"The interviewees' main implementation and scaling concerns included providing mentoring and support, securing staff time, and having a unified scaling approach."

According to SRI, the seven grantees reached 9,955 students at 135 institutions combined. The grant project sidebars detail the numbers of students and institutions

University of Wisconsin-Milwaukee

UWM developed its U-Pace instructional approach for Introduction to Psychology, a course that most students take. U-Pace provides the capacity for students to receive relatively "high touch" supports within large introductory courses without a large infusion of funding. U-Pace integrates academics and supports for all students in courses that have adopted the model. More specifically, U-Pace combines self-paced, mastery-based learning with "Amplified Assistance"—tailored emails from instructors to students, encouraging students to succeed. The mastery-based component allows students to move along to new content after they master the concepts in each module (as evidenced by earning at least 90% on a multiple-choice quiz aligned with the module). Students can retake quizzes as many times as they wish without penalty, but they must wait at least one hour before retaking.

The two components—mastery-based learning and Amplified Assistance—are intended to work in tandem. An objective of the two-pronged approach is to give students more control over their learning; the model's theory of action is that the feeling of control will lead to greater learning and academic success. UWM worked with the Society for the Teaching of Psychology, which functions as Division 2 of the American Psychological Association, to scale the adoption of U-Pace at other institutions.

Evidence. Several analyses, some of which included comparison groups and random assignment, found that students in U-Pace courses, including academically underprepared students, earned higher test scores and course grades than students in traditional courses, even six months after the course ended. (More information can be found in an EDUCAUSE Review Online article and in the "Evidence of Learning and Course Completion" section of this report.) In terms of student outcomes, 56% completed the course, 46% demonstrated subject matter mastery, 46% demonstrated evidence of deeper learning; no data were reported about persistence to the next academic term.

reached during the grant period. (The totals may have increased since the grant period concluded.) The innovations were used predominantly by instructors who taught science and education courses, although the innovations were also used in social science and math courses.

The survey findings that a majority of instructors were assessing deeper learning and using student data (see the sidebar, "Instructors' Perceptions of the Innovations") support some of the design assertions made earlier regarding the deeper learning approaches taken by the grantees. On the other hand, almost half of instructors (43%) reported that project-based learning was not a feature of the innovation. This may be a missed opportunity for promoting deeper learning through these innovations.

Instructors were more likely to indicate that they did not encounter many implementation challenges, but did report challenges with technology such as access, reliability, and ease of use (49%) and student resistance (26%). Instructors using all 29 grantee innovations noted these same challenges. According to SRI, instructors described student resistance as a reluctance to take responsibility for initiating and managing their own learning—suggesting that efforts to promote deeper learning require support for students to transition to a more active role in their own learning.

The interviewees' main implementation and scaling concerns included providing mentoring and support, securing staff time, and having a unified scaling approach. They reported that mentoring increases the chances of successfully scaling the innovation. Instructors and staff cannot use a technology effectively absent the appropriate supports and time to learn. Having a faculty resource center with available training and support, along with release time from teaching a course provided by the college or university, helps lead instructors scale their efforts across a campus and to other campuses. For example, MEIBL focused on providing supports to faculty and scaling slowly within a course and then scaling across courses. The faculty involved started with entry-level courses (general chemistry) and then moved to organic chemistry and upper-division biochemistry courses, so that students who continue in a science major will have reinforcing experiences.

In order to scale effectively, sufficient staff time must be devoted to the effort. As one interviewee stated, "It takes an enormous amount of time to create and implement and sustain and scale work like this; you basically need a full-time person to do that." Many faculty members wish to remain in the classroom for at least part of their time, and many also have publication requirements. It is difficult to weigh the pressures of existing responsibilities against the time investment new innovations require. Bryn Mawr faculty reported that it also took a great deal of time to vet and test different online resources to support the best blended learning approach for their own courses.

Furthermore, grantees recommended, based on their experiences, that developers ensure that applications are not tethered to particular platforms, given how quickly platforms change. Web-based applications can be used by anyone with access to the Internet and are not subject to revision or obsolescence if platforms change. This accessibility can help with scale, as not needing to integrate with existing platforms can allow for easier widespread adoption.

University of Massachusetts, Amherst

UMass and its partners from Springfield Technical College, Greenfield Community College, and Holyoke Community College developed the Math Fundamentals Tutor to Improve College Completion project in order to (1) promote deeper learning for students in several mathematics courses who are at-risk of earning a nonpassing grade/dropping out of the class and (2) enable students, faculty, and staff to use real-time analytics to increase student success. The intervention begins with assessment and placement and continues with individualized instruction through Wayang Outpost, an online adaptive tutor that changes its responses in order to meet a student's learning needs. Wayang Outpost utilizes mathematics problems, hints, interactive media, and videos. It is "smart" software in that it has an "adaptive mechanism that tailors the sequencing of problems using cutting-edge research in cognitive science, multiple learning paths, and embedded assessment." It uses affective and motivational information from student logs to tailor nonacademic supports. The application is used in basic, preparatory, and intermediary algebra and geometry and in developmental math.

Evidence. UMass found that nearly 3,000 students in Massachusetts and Arizona using Wayang Outpost demonstrated significant learning gains, in addition to improved attitudes, increased motivation, and reduced frustration and anxiety. In terms of student outcomes, 81% completed the course, 81% demonstrated subject matter mastery, 81% demonstrated evidence of deeper learning, and 49% persisted to the next academic term.

Evidence of Learning and Course Completion

SRI's evaluation found that students who participated in efforts funded through the deeper learning challenge area generally had better outcomes than did students in other challenge areas, although none of the differences are statistically significant. These results, presented in table 3, do not include data from simSchool, which were not available.

Table 3. Student academic results by challenge area

	Completion		Subject Mastery		Deeper Learning		Persistence	
Challenge Area	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**
Deeper learning	**85**	**2,239**	**74**	**2,168**	**56**	**1,992**	**83**	**1,421**
Blended learning	75	26,548	60	26,546	41	13,346	67	11,967
Open core courseware	83	8,324	67	7,236	49	2,549	66	4,856
Learner analytics	89	14,347	65	10,326	NA	NA	72	4,882

Effect sizes of the outcomes—the impact of the innovation on student outcomes in relation to a control group (students in the same course but without the innovation)—may shed more light. SRI estimated the effect sizes of the six grant projects with outcomes data and statistically significant effects were found only for University of Wisconsin–Milwaukee's U-Pace project. The effects were positive, meaning that students in U-Pace classrooms had better outcomes than students in control-group classrooms. The effect size of 0.621 was the largest effect of any of the 22 of 29 Building Blocks projects included in the analysis, which is the equivalent of raising the average student's score on a 100-point exam from 50 to about 73. U-Pace had significant and positive effects for both low-income students and their higher-income peers. None of the other deeper learning projects had significant effects, meaning outcomes for students in the deeper learning project classrooms were not statistically different from outcomes for students in control-group classrooms.

"SRI also reported that, with regard to U-Pace, 'Program leaders and instructors attribute the success of the program to giving students the opportunity to work through the course at their own pace and receive faculty feedback, study strategies, constructive support, and encouragement.'"

SRI concluded that the majority of the Building Blocks projects did not require substantial changes in faculty practices and classroom pedagogy as a whole, except for U-Pace (which moved away from lecture-based instruction toward mastery-based progression) and one other project (Do the Math! from Chattanooga State Community College, which was funded by NGLC under the blended learning challenge area and was not studied for this report). This may be one of the reasons why significant effects on outcomes were found for U-Pace but not for the other deeper learning innovations. SRI also reported that, with regard to U-Pace, "Program leaders and instructors attribute the success of the program to giving students the opportunity to work through the course at their own pace and receive faculty feedback, study strategies, constructive support, and encouragement."

Conclusion

Even with the limited data available regarding these innovations' contributions to deeper learning, it is clear that challenges for students, faculty, and staff must be overcome in order for technology-enabled innovations to improve student learning.

Instructors found that students need support to transition into deeper learning in order to be able to take ownership of their own learning in a manner different from in traditional classrooms. An abrupt entry into a deeper learning–focused classroom is not likely to be a successful strategy.

Similarly, faculty members need training and support in order to create, implement, and sustain reforms that change how and what students learn as fundamentally as deeper learning intends to do. Faculty and staff developed the innovations discussed in this report to meet specific needs on their campuses; these innovations were not developed by information technology specialists. Faculty and staff networks, interests, and commitment to supporting teaching and learning are all hallmarks of this group of projects. Many instructors cannot redesign their courses, or adopt new technologies, without significant supports and resources. If instructors do not have the appropriate training, the models might not be implemented with fidelity.

Moreover, these efforts call into question the traditional academic calendar and sequence of courses that often are not interconnected in a meaningful way. Achieving deeper learning appears to require more than one course over one academic term, which implies the need for significant faculty collaboration to continue certain strategies and pedagogies over the course of several classes.

U-Pace, the only innovation that showed statistically significant improvements in student learning, moved away from lectures and used a mastery-based approach. This finding suggests that deeper learning may require an even deeper level of pedagogical redesign. Appending an innovation to a traditionally taught course within a traditionally organized curriculum may not generate hoped-for improvements in student outcomes. Given the nascent nature of both technological and deeper learning reforms in postsecondary education, these initiatives represent an important first phase of experimentation. The projects' efforts provide critically important information for others who are leading the next phase of efforts to enable deeper learning and engagement for students in postsecondary education.

Bryn Mawr College

This project studied whether blended learning could provide benefits in the more intimate context of a residential liberal arts college and, in particular, whether it could improve learning outcomes, persistence, and postsecondary completion in STEM fields. In academic year 2011–12, Bryn Mawr faculty piloted blended approaches in 18 courses, with a particular focus on introductory STEM courses. For the online component of these courses, faculty developed or adopted existing online, interactive lessons, tutorials, and quizzes, which not only introduced students to concepts and skills but also enabled them to practice for course assessments, evaluate their learning, and get immediate feedback.

Students could work online as much or as little as they needed to in order to master the concepts and skills. Faculty members used the data from the online activities to identify and support struggling students and adjust in-class instruction and activities. Faculty also used the online learning component to free up class time and prepare students for activities designed to foster deeper learning—such as project-based learning or more intensive group discussion. Bryn Mawr faculty shared their experiences with a consortium of 40 liberal arts colleges. Forty faculty members from 25 of those colleges developed and piloted blended courses for academic year 2012–13, although the timing of these pilots made it difficult to collect outcome data from partners during the grant period.

Evidence. Of the 729 students enrolled in Bryn Mawr College pilot courses, just over 94% of students in participating courses completed their courses with a grade of 2.0 or higher, and 98% remained enrolled in the college the following semester; 14% of the students in these courses were low income (Pell-grant eligible), and they completed, reenrolled, and demonstrated evidence of deeper learning at roughly similar rates as the population as a whole—94%, 94%, and 36%, respectively. However, only 70% of low-income students achieved subject mastery, compared to 86% of all students.[1]

1. Next Generation Learning Challenges, Grant Recipients, Bryn Mawr College.

Resources

The following websites provide information, materials, and examples of deeper learning in K–12 and higher education.

- Deeper Learning from the William and Flora Hewlett Foundation
- Deeper Learning from the Alliance for Excellent Education
- Deeper Learning Resources from Deeper-Learning.org
- Deeper Learning Resources from Getting Smart
- Deeper Learning from Next Generation Learning Challenges

These tools and readings support the design, adoption, and measurement of deeper learning.

- Breakthrough Models for College Completion: The Next Generation of Models for Higher Education, a compilation of nine new postsecondary degree program models awarded grants from NGLC in 2012. These models are examples of the fundamental, comprehensive redesign that findings from this report suggest may hold greater promise of promoting deeper learning outcomes than supplemental resources for individual courses.
- Deeper Learning MOOC, a free, flexible, nine-week course that will allow K–16 educators to learn how deeper learning can be put into practice.
- Blended Learning in the Liberal Arts Conference, an annual forum for faculty and staff to share findings and experiences related to using blended learning to improve learning outcomes and support the close faculty-student relationships and deep, lifelong learning that are the hallmarks of a liberal arts education.
- Assessing Deeper Learning from the Alliance for Excellent Education—a 2011 brief that shows what assessments measuring deeper learning might look like and how they can be implemented feasibly.
- Deeper Learning: Authentic Student Assessment from Edutopia—an article by Bob Lenz, founder and chief of innovation for Envision Education, describing three leverage points for developing and implementing a deeper learning student assessment system.
- Spotlight on Deeper Learning from Education Week—a collection of articles addressing teaching students with disabilities, dual-language instruction, creativity, brain and learning sciences, and mastery-based learning.
- How Digital Learning Contributes to Deeper Learning from Getting Smart—a report by Tom VanderArk and Carri Schneider identifying personalized skill building, schools and tools, and extended access as three primary ways that digital learning promotes deeper learning.

Resources (continued)

Publications and presentations from NGLC grant recipients provide further information about the innovations.

Abilene Christian University, MEIBL

- Powell, Cynthia B., Scott Perkins, Scott Hamm, Rob Hatherill, Louise Nicholson, and Dwayne Harapnuik. "Mobile-Enhanced Inquiry-Based Learning: A Collaborative Study." EDUCAUSE Quarterly (December 15, 2011).

Eckerd College, IPAL

- Junkin, Bill. "Beyond Clickers: Increasing Student Learning Through In-Class Polling Using Web-Enabled Devices." NGLC (blog). July 10, 2013.

University of Wisconsin-Milwaukee, U-Pace

- Barth, Dylan, Raymond Fleming, Laura Pedrick, and Diane M. Reddy, "Understanding the Impact of Online Instruction: Strategies and Lessons from the U-Pace Instructional Approach." Poster presented at EDUCAUSE 2013, Anaheim, California, October 15–18, 2013.
- Reddy, Diane M., Raymond Fleming, Laura E. Pedrick, Danielle L. Jirovec, Heidi M. Pfeiffer, Katie A. Ports, Jessica L. Barnack-Tavlaris, Alicia M. Helion, and Rodney A. Swain. "U-Pace Instruction: Improving Student Success by Integrating Content Mastery and Amplified Assistance." Journal of Asynchronous Learning Networks 17, no. 1 (January 2013).
- Reddy, Diane M., Raymond Fleming, and Laura Pedrick. Increasing Student Success: Evaluating the Effectiveness of U-Pace Instruction at UWM. SEI case study. Louisville, CO: ELI, September 2012.

Wake Forest University, BioBook

- Bennett, Kristin Redington, and Allen Daniel Johnson. "Using Multi-Node Tools for Student Success in Non-Major Science Classes." EDUCAUSE Quarterly (December 15, 2011).

Association for the Advancement of Computing in Education, simSchool

- Gibson, David. "Psychometric Considerations for Simulation-Based Assessments of Teaching." Forthcoming. Draft version.
- Kruse, Stacy, and David Gibson. "Next Generation Learning Challenge: Simulating Teaching." EDUCAUSE Quarterly (December 15, 2011).

Bryn Mawr College

- Spohrer, Jennifer. "Blended Learning in a Liberal Arts College Setting." ELI Webinar, June 2, 2014.

ABOUT THE AUTHOR

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NEXT GENERATION LEARNING CHALLENGES

Next Generation Learning Challenges (NGLC) accelerates educational innovation through applied technology to dramatically improve college readiness and completion in the United States. This multi year program provides investment capital to expand the use of proven and emerging learning technologies, collects and shares evidence of what works, and fosters innovation and adoption of solutions that will dramatically improve the quality of learning in the United States, particularly for low-income students and students of color.

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