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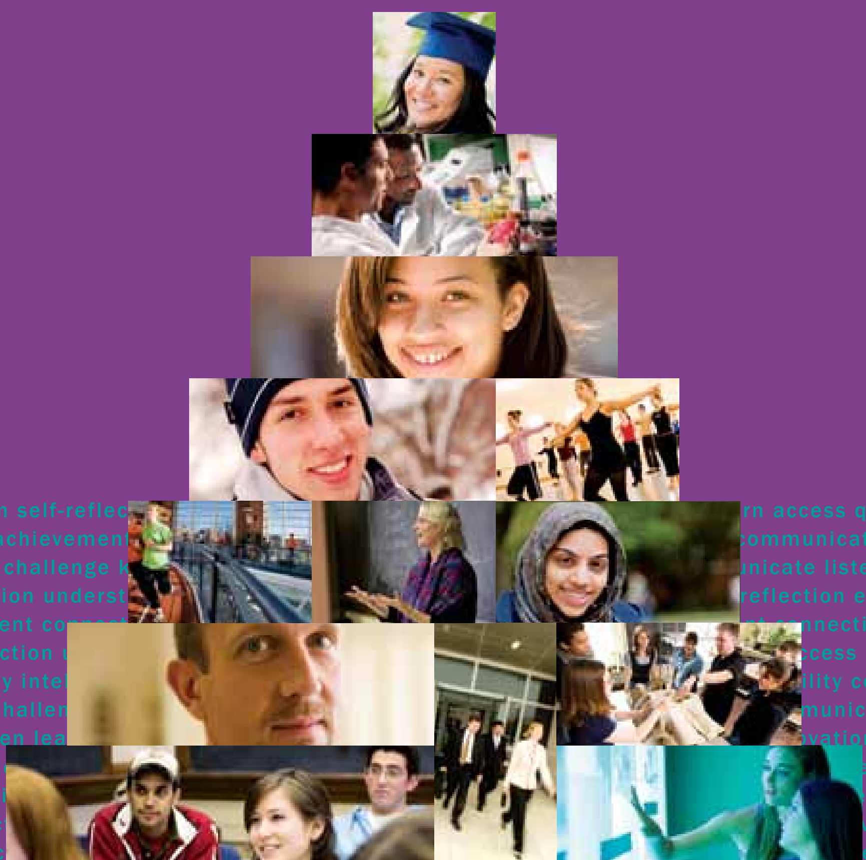
Assessing Learning in Online Education:
The Role of Technology in Improving Student Outcomes

Matthew Prineas and Marie Cini

Foreword by Peter Ewell



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About the Authors

Matthew Prineas
Matthew Prineas is the Academic Director for English, Literature, and Humanities in the School of Undergraduate Studies at University of Maryland University College. He received his PhD in English language and literature from the University of Rochester and an M.A. in English from the University of Michigan, Ann Arbor. Previously, he worked as an administrator at the National Endowment for the Humanities, where he coordinated curriculum development for EDSITEment, an online resource for K-12 teachers across the country. From 1995-2000, he was a faculty member in the English department at Idaho State University, and has published articles on Milton, Henry Vaughan, Ben Jonson, and other seventeenth-century authors.

Marie Cini
Marie Cini is the Vice Provost and Dean of the Undergraduate School at University of Maryland University College, where she oversees 32 baccalaureate programs serving 67,000 students worldwide. She earned a PhD and a master's degree in social psychology from the University of Pittsburgh, as well as a master's degree in counselor education from Pennsylvania State University. Before UMUC, she was an associate vice president for Academic Affairs and interim dean of the School of Management at City University of Seattle. During her tenure there, she reorganized and led the school's e-campus initiative, while also establishing common curriculum standards, enhancing the Prior Learning Assessment process and linking academic affairs staff in the U.S. more closely with those in the international arena. Dr. Cini has published and presented extensively on the topics of authentic assessment and academic integrity, leadership development in adult learners, retention and adult learners, group newcomers and innovation, and program development across cultures.

In this compelling new NILOA Occasional Paper, Matthew Prineas and Marie Cini argue persuasively not only that the connections between online education and learning outcomes assessment are deep but also that the mediated settings provided by online education have the potential to significantly improve assessment and its capacity to improve teaching and learning.

Peter T. Ewell
Vice President, NCHEMS Senior Scholar, NILOA

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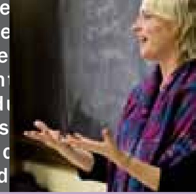
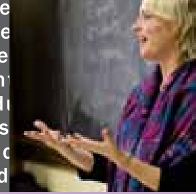


Abstract

Assessing Learning in Online Education

The national learning outcomes assessment (LOA) movement and online learning in higher education emerged during roughly the same period. What has not yet developed is a sophisticated understanding of the power of online learning and its concomitant technologies to change how we view, design, and administer LOA programs. This paper considers how emerging techniques, such as data mining and learning analytics, allow the use of performance and behavioral data to improve student learning not just for future iterations of a program but in real time for current students. Also considered are powerful learning methodologies which predate online learning but have found renewed utility when coupled with new technologies for assessing and assisting student learners. In this paper, we postulate that technology will enable educators to design courses and programs that learn in the same way that individual students learn, and we offer some conditions that we believe are important to further this goal. We conclude with a consideration of how the faculty role will necessarily change as a result of these advances in our understanding of using technology to improve learning outcomes.



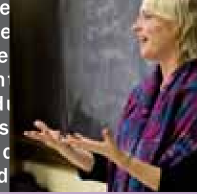
Foreword

Although online education for college and university study has experienced remarkable growth over the past two decades, the links of online education to the assessment of student learning outcomes have been largely overlooked. While the ongoing "no significant difference" debate—which deploys assessment techniques to determine whether computer-mediated approaches are "as good as" face-to-face classroom delivery—may seem an exception, in my view, that debate has been fruitless. In this compelling new NILOA Occasional Paper, Matthew Prineas and Marie Cini argue persuasively not only that the connections between online education and learning outcomes assessment are deep but also that the mediated settings provided by online education have the potential to significantly improve assessment and its capacity to improve teaching and learning.

Online education and assessment practice in higher education evolved contemporaneously, as Prineas and Cini observe. Assessment's beginning is usually dated to the mid-1980s, when "distance education" consisted largely of paper-and-pencil correspondence courses and what now seem relatively primitive one-way video communications. Now, of course, online education is multifaceted, sophisticated, and almost ubiquitous. Assessment, meanwhile, has developed from the ad hoc use of available standardized tests like the GRE and the ACT to the deployment of a powerful array of instruments, portfolios, and rubrics—many of which are featured on the NILOA web page. Yet while online education and assessment in higher education developed in parallel, these two "movements" intersected little during that time. Now they are poised to do so, Prineas and Cini emphasize, and both will benefit.

The authors offer three broad observations to support this claim. The first centers on the ability of online learning management systems to harvest data not just on what students learn but also on students' every learning activity. Historically, one of the major impediments in using assessment results to improve instruction has been the lack of data about student learning behaviors and the inability to connect analytically the behavioral evidence for further educational development. Instruments like the National Survey of Student Engagement (NSSE) were designed to gather such data in conventional learning environments. In online learning environments, however, these data are collected automatically in learning management systems that obtain an electronic record of everything the student does online. While making sense of all these data will certainly be a challenge, data mining techniques and what Prineas and Cini term "data analytics" are already guiding improvement.

The authors' second broad observation is about the growing dominance in the design of online education programs of the asynchronous mastery learning approach. Learning assessment is integral to the design of these programs because students advance from module to module only after demonstrating what they know and can do. In contrast to most assessment programs in traditional academic programs, this means that instead of assessing just a small sample of students, these programs assess ***every*** student against established learning objectives. What is more, these programs require no additional data collection, no "add-on" testing, nor the application of rubrics to rescore already graded student work, as is common in portfolio-based assessment approaches.



Foreword continued

The authors' third broad observation is about the emerging best practices for building effective learning environments online—practices that are analogous to the famous *Seven Principles of Good Practice for Undergraduate Education*, articulated by Arthur Chickering and Zelda Gamson some 25 years ago, but that are being applied in the new milieu of virtual learning. Like the original principles, these practices are intended to guide good pedagogy, but they also require an approach to curriculum design that is thoroughly intentional and that incorporates learning outcomes from the outset. Consistent with the mastery learning approach, this is a far different situation from that of conventional assessment—in which learning outcomes are frequently developed after the fact and applied to evaluate the effectiveness of courses never explicitly designed to fit together. Another common feature of online education that is favorable to the development of effective assessment, the authors note, is disaggregated faculty functions. While instructional design, content delivery, advising and mentoring, and the assessment of student work are all performed by the same individual in the conventional classroom, in online settings these functions are frequently undertaken separately. Additionally favorable to the development of effective assessment is the fact that, in online education, assessment is a distinct activity of faculty, providing them opportunities to undertake assessment activities more deeply, more thoroughly, and professionally than in their conventional grading activities.

Because I have seen much of what Prineas and Cini describe through the lens of a particular institution—Western Governors University (WGU), which my organization helped design and where I continue to serve as a council member—I am delighted to introduce this paper. WGU is based entirely on the mastery learning approach and has exactly the kind of "unbundled" faculty functions the authors describe. While WGU is only just beginning to harness "learning analytics," its remarkable growth and development owe much to the fact that its structure and operations are based almost entirely on the principles these authors articulate here.

Peter T. Ewell
Vice President, National Center for Higher Education Management Systems (NCHEMS)
Senior Scholar, NILOA

Assessing Learning in Online Education: The Role of Technology in Improving Student Outcomes

Matthew Prineas and Marie Cini

Online education, defined as a platform for delivering educational content and facilitating instructor-student interaction over a computer network (Shelton & Saltsman, 2005, pp. 3–4), came of age in the 1990s and grew rapidly over the next decade (Allen & Seaman, 2010; U.S. Department of Education, 2003; U.S. General Accounting Office, 2002). During roughly the same period, increasing calls for accountability in higher education led to the development of measures to establish the value of higher education in general, through the mechanism known as "learning outcomes assessment" (LOA). Besides historical proximity, these movements—online education and LOA—shared important features: both represented the introduction of disruptive concepts into the traditional face-to-face, faculty-centric classroom, and both raised questions about the efficacy of traditional models of teaching and learning measurement that had remained essentially unchanged for centuries. Yet, for the most part, the two movements progressed independently. Early LOA efforts were focused on the traditional or face-to-face classroom, with online courses assessed only to determine whether the learning outcomes matched the face-to-face "standard." Even today, LOA efforts tend to use the same approach, asking the same questions about face-to-face classrooms as about online classrooms. What has not emerged is a more sophisticated understanding of the power of online learning to change how we view, design, and administer LOA programs.

Technological developments have the potential to re-energize LOA efforts for both traditional and online education.

Online education exists because technology made it possible. Technology is also making possible an increasing ability to track, assess, and respond to the behaviors and mastery levels of students in online courses with far greater depth and rapidity than ever before. Researchers are focusing on the large amounts of student data that can be gathered and archived in online courses and programs in order to "mine" the data for patterns that can assist educators to improve learning outcomes. Referred to as "learning analytics" in the higher education setting, these approaches enable faculty and course designers to make rapid changes in instructional practices and curriculum, and they empower students to make informed decisions about their learning behaviors and course choices. Emerging technologies are also reinvigorating powerful instructional methodologies such as mastery learning that in some cases predate the emergence of online education by decades (Scrima, 2009).

These technological developments have the potential to re-energize LOA efforts for both traditional and online education. Although LOA efforts have grown substantially over the past decade, most institutions have used assessment results simply to satisfy accreditation pressures, unfortunately, instead of using them to improve student learning (Kuh & Ikenberry, 2009). Pressures from the public and from the federal government to be more accountable for the outcomes of higher education no longer allow us to pay only lip service to student learning. The promise of learning outcomes assessment is that through continuous improvement of curriculum and instruction, learning achievement for all students should increase. Online education and its concomitant technologies promise better ways to help *all* our students reach their full potential.

In this paper we describe the power of learner analytics to improve student learning not just for future iterations of a program but in real time for current students. We also explore several powerful instructional methodologies that have found renewed utility in the online environment. We postulate that technology will enable educators to design courses and programs that learn in the same way individual students learn, and we offer some conditions that we believe are important to further this goal. Finally, we present some concluding thoughts about the ways in which the faculty role will necessarily change as a result of these advances in our understanding of using technology to improve learning outcomes.

In this paper we describe the power of learner analytics to improve student learning not just for future iterations of a program but in real time for current students.

Learning Analytics: Designing Data-Driven Interventions to Support Student Learning

Colleges and universities typically offer online classes through course management system (CMS) software, which provides the virtual classroom space for faculty and students to interact over the course of a semester (Watson, 2007). These interactions are tracked and stored, making CMS an important potential source of data related to student learning. Using current CMS software—which delivers curricular content in various formats including text, audio, and video—students and faculty can conduct synchronous or asynchronous discussions, faculty can administer quizzes and exams, students can submit papers and assignments, and faculty can provide grades and other forms of feedback. Within a single online course section, then, an individual faculty member has access to a wealth of quantitative and qualitative data about student engagement, for example, number of words posted, total number of posts, average length of posts, and the text of every student comment or question from the first week's discussion to the last. The sophistication and reach of CMS storage and tracking features continue to grow. Additional kinds of data gathered by CMS software may include how frequently students log in to their courses; the length of time they spend on particular tasks such as reading a content page, taking self-directed quizzes, and so on; and customized statistical analyses of individual or group responses to quizzes. All such transactions are archived, during and after the semester, for every online section of every course offered at an institution. Thus, institutions with online enrollments in the thousands or tens of thousands come to possess a vast repository of data with potential applications in the assessment student learning.

An understanding is growing in higher education of how to utilize these data for improved student outcomes. Over the last several years, a movement has emerged that attempts to uncover patterns in data stored on the CMS and to design interventions accordingly. Because these applications are so new, the terminology of the field is still in flux; in recently published papers and conference presentations, it is common to see the terms "data mining," "data analytics," "academic analytics," and "learning analytics" used to describe a family of related techniques and technologies for finding pattern in large data sets (for example, see the annual conference program of the Western Cooperative for Electronic Telecommunications [WCET] at http://wcetconference.wiche.edu/). Such techniques have been in existence for years in the business world, typically under the rubric "data analytics" or "business intelligence," and have become more sophisticated than ever in profiling customer behavior (as anyone who receives recommendations from Google, Amazon, or Netflix knows). A recent and useful effort to define terms appropriate for the higher education setting has distinguished between *academic analytics*, in which data are examined based on a particular hypothesis or research question, and *data mining*, which describes a family of techniques, not necessarily driven by a hypothesis or question, for detecting patterns in large bodies of data. Both approaches have applications in higher education (Baepler & Murdoch, 2010). For the purposes of this paper, we refer to all of these techniques as "learning analytics."

Learning analytics have recently received a great deal of attention in their role of helping educators focus efforts and resources when designing interventions for student success. For example, researchers have used data analytics to discern which types of students are most likely to be at risk of failure at various stages in their academic journey. Once institutions identify these student groups, they can design interventions such as supportive services, enhancements to curricula, or improved instructional practices. A simple form of intervention, based on patterns identifying at-risk students in the online classroom, is the use of automatic emails sent to students to flag key problems such as a student's a) not posting in a discussion thread by a certain date, b) not submitting an assignment, and/or c) not engaging frequently enough in online class discussion. This basic form of tracking can be done independently of the instructor; the message can be automatically sent to a student, noting the missed work or interaction, along with the reason why it is important for the student to engage or re-engage with the course.

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In sophisticated course management systems these messages can even share the knowledge that a certain percentage of students who do not engage in these targeted ways are "likely to fail," thus motivating students to either engage or seek help. A pioneering example of such an early system designed and used by Purdue University—Signals—draws from 20 data points. The Signals algorithm synthesizes quiz and test data, but it can also incorporate time spent on task and other behavioral measures. These data are spliced together and presented back to the student as well as to the faculty member in the intuitive format of traffic signals: red, yellow, or green lights reflecting the level of the student's performance (Arnold, 2010). Similar to the Signals dashboard, another approach assisting student learning has been developed by researchers at the University of Maryland Baltimore (UMB), who began with the observation that students earning a D or F used the university's CMS 39% less frequently than students earning a grade of C or higher. Reasoning that these students might make better choices about their own engagement in online discussions if they had access to real-time data about the effects of their classroom behaviors, the researchers designed a tool that allows students to follow in real time their levels of activity in the online classroom as well as their grades compared to an anonymous summary of their peers' performance (Fritz, 2011). All this information is stored in most CMS software already; the UMB tool simply made it accessible and provided an understanding of the data for each student.

Learning analytics are being used not just in the classroom, but in a variety of other operational functions supporting online programs. For example, instructional designers can now use CMS to improve courses through "built in" feedback mechanisms that continually (not just as the end of a course) gather user feedback on the relative usefulness of course features. In the past, such improvements required the labor-intensive analysis of individual student evaluations after the semester. Increasingly, mechanisms for user feedback can be built into the online course, so that as students in multiple sections of a course use and respond to various course features, course designers receive large amounts of data in real time about which features students are using or not using, which features are problematic, and so on ("Using data," 2011).

Online Mastery Learning: Closing the Gap Between Assessment and Learning

Another set of emerging tools for assessing student outcomes may be grouped under the heading *online mastery learning*, which combines the decades-old instructional methodology of mastery learning with the technology of online education. First developed in the 1960s and early 1970s, mastery learning represents an instructional approach that radically closes the gap between assessing student achievement and intervening to assist and advance student learning (Scrima, 2009).

In mastery learning, students must demonstrate proficiency in a particular learning objective before they are allowed to progress to a subsequent stage. Assessment and feedback alternate in frequent cycles as the student progresses through each stage of the curriculum. Time to completion becomes fluid. Students begin with differing sets of prior knowledge, progress at different rates, and master the course curriculum within different time frames. Clearly and precisely defined learning outcomes—absolutely crucial for this instructional methodology—must adequately define the criteria of mastery toward which students are working. Of equal importance are the precise definition and accurate alignment of incremental learning objectives that delineate the intermediate stages in the pathway toward mastery. While research into mastery learning efforts has supported its efficacy, at the same time it has highlighted the substantial investment of time and faculty involvement required to implement an effective curriculum using this approach (Kulik, Kulik, & Bangert-Drowns, 1990).

Recent advances in online learning are breathing new life into this instructional methodology, however. In a fully online curriculum, a variety of assessment instruments—and the technical means for instant feedback—can be built into every instructional activity. Previously static aspects of an online course (for example, content areas containing background reading) can be designed as interactive, with embedded assessments testing then assisting students as they advance through the curriculum, whether on their own, in collaboration with other students, or with the help of an instructor. Particularly important, the process of learning for each individual can be tracked, monitored, and assisted. Underlying all the elements of such a course are data collection "engines" capable of gathering and quickly processing a large amount of information on student performance. This marriage of mastery learning and technology allows instructors to monitor students' learning and to intervene when students need assistance.

Computer-mediated approaches to mastery learning are being developed by a smattering of researchers and for-profit companies. Current leaders in this effort include Carnegie-Mellon's Open Learning Initiative (OLI) and the Khan Academy.

With open learning courses in fields ranging from engineering to French, OLI is working to develop multiple feedback loops for rapidly collecting, disseminating, analyzing, and acting on student learning data:

- Feedback to students: Built into the mastery model of OLI courses are mechanisms that provide students with feedback even during the process of problem-solving, allowing for self-paced, incremental progress toward learning objectives.
- Feedback to instructors: OLI researchers are developing ways to harness the large amounts of assessment data generated by the model and to present these data to instructors in a manner that empowers them to intervene in timely and effective ways (Bajzek et al., 2008).
- Feedback to course designers: The OLI model provides course designers with rapid and frequent feedback to improve online courses in real time. In addition, the OLI model looks not only at patterns of how students use particular course features but also compares those usage patterns with learning assessment results.

Much in the news of late, the Khan Academy (http://www.khanacademy.org/) is known for its collection of short instructional videos on topics ranging from arithmetic to finance, narrated and posted on YouTube by Salman Khan, a former hedge fund manager who aimed, initially, to tutor his cousins in math. The Khan Academy approach, now augmenting videos with technology and mirroring online mastery learning, is being used in K–12 settings to complement traditional classroom instruction (Rasicot, 2011).

Computer-mediated approaches to mastery learning are being developed by a smattering of researchers and for-profit companies. Current leaders in this effort include Carnegie-Mellon's Open Learning Initiative (OLI) and the Khan Academy.

Like OLI, the Khan Academy approach reverses the usual relationship of homework and lecture or classroom discussion. At home, students learn content material at their own pace by working through incremental, interactive lessons and tutorials designed on the mastery model of progression. Data is collected that instructors can use to help students learn concepts they may be struggling with in the computer-mediated lessons. The classroom then becomes a place of active work, with students using class time to complete projects and assignments, either individually or in groups, with an instructor present to monitor, coach, and assist their efforts.

Underlying the Carnegie Mellon OLI and Khan Academy models of mastery learning is an assessment methodology that also predates online learning but that in recent years has been energized by the growing capacity to track, store, and analyze student learning data. Adaptive achievement testing, according to Wainer (1990), bases test questions on students' level of prior knowledge as shown in their responses to previous questions. Adaptive testing is more efficient in that fewer questions can be used to assess a student's level of knowledge than with traditional linear testing, which requires a student to answer all low-level questions before moving to more difficult material. With the use of adaptive testing, instructors can quickly determine students' skill level and provide them with just-in-time learning, making optimal use of their prior knowledge. This assessment method is also made simpler through course management systems that connect new learning materials to the questions the students answer incorrectly.

Courses and Programs That Learn

Just as individual learners need feedback that is timely, targeted, and likely to be acted upon, courses and programs also need feedback loops that efficiently and quickly direct the results of assessment to improve student learning. The emerging tools for online assessment examined previously are primarily being used to assist individual student learning *in vivo*, for current students at the time of greatest need. As a national movement, however, learning outcomes assessment is concerned mostly with adjustments to curricula and instruction at the program level, generally applying these adjustments to assist *future* students to achieve at greater levels. To be truly revolutionary, student learning data generated in online technologies must be applied in a systematic way at the program level and in real time, so that students can benefit from ongoing adjustments at the program level—changes in curricula, course sequences, academic requirements, resource allocation, and so on. Online technologies can provide this real-time, program-level feedback loop in ways that traditional classrooms simply cannot.

To be truly revolutionary, student learning data generated in online technologies must be applied in a systematic way at the program level and in real time, so that students can benefit from ongoing adjustments—changes in curricula, course sequences, academic requirements, and resource allocation. Online technologies can provide this feedback loop in ways that traditional classrooms simply cannot.

Two preconditions seem necessary for effectively scaling emerging technologies for assessment in the online classroom to the needs of program-level, real-time LOA efforts. First, as the example of online mastery learning suggests, educational technology will be most effective when coupled with a conceptual learning model—for example, a set of best practices about the kinds of interventions that have the greatest impact on student performance in the classroom. Without a learning model to guide course-level uses of online assessment technology, ad hoc applications by individual instructors will be difficult to scale up to instructional changes across multiple sections of the same course or across a program. Second, to ensure that assessment data are actionable at the course and program level, there needs to be a tight integration of learning outcomes throughout the curriculum, including assignments, discussion, course material, and instructional practices. Both of these preconditions—a guiding learning model and tight curricular integration—of course, are essential for LOA in any program, online or face-to-face. With the ever-increasing volume of assessment data available from emerging technologies, however, such structural underpinnings are becoming even more important. Without a model to guide this work and to serve as a framework for collecting and interpreting this great amount of data, we will find ourselves simply unable to use it effectively.

Fortunately, the foundations already exist for a learning model appropriate for the online environment. The learner-centered tenets, based on a broad review of the learning literature, articulated in the influential *Seven Principles for Best Practice in Undergraduate Education*, by Chickering and Gamson (1987), are particularly applicable to the task of identifying interventions that impact student performance: faculty engagement, student collaboration, active learning, frequent and prompt feedback, time on task, high expectations, and respect for diversity (see also Chickering & Ehrmann, 1996). Although initially developed for the face-to-face environment, the Chickering/Gamson model has been utilized widely in the online environment. Palloff and Pratt (2009), in *Assessing the Online Learner: Resources and Strategies for Faculty*, provide numerous examples and models for designing effective assessments in the online modality as well as effective interventions based on outcomes data. These educators offer institutions both a theoretical framework based on the learner-centered approach and a practical guide to online assessment practices leading to improvements in instruction, courses, and programs. Similar approaches—emphasizing interactivity, instructor feedback, critically engaging assignments, and total time on task—are reflected as well in a growing number of published best practices for online education. Among the first, if not the first, of such sets of published guidelines was the 1995 document produced by the Western Cooperative for Electronic Telecommunications (WCET) in cooperation with the eight regional accrediting bodies, Principles of Good Practice for Electronically Offered Degree and Certificate Programs. A more recent best-practices document produced by WCET (2009), *Best Practice Strategies to Promote Academic Integrity in Online Education, Version 2.0.*, emphasizes assessment practices in the online classroom. The practices in these documents are supported as well by reviews and meta-analyses of comparative studies on online and face-to-face education published over the past several years (see Bernard et al., 2004; Tallent-Runnels et al., 2006; U.S. Department of Education, 2010; Zhao, Lei, Yan, Lai, & Tan, 2005).

Another precondition for effectively scaling up course-level assessment data to changes at the program level is the integration of learning outcomes throughout all aspects of the curriculum, including assignments, discussion, course material, and other instructional features through a "backward design" process beginning with robust program outcomes.

The second precondition for effectively scaling up course-level assessment data to changes at the program level is the integration of learning outcomes throughout all aspects of the curriculum, including assignments, discussion, course material, and other instructional features through a "backward design" process beginning with robust program outcomes. Many universities, however, using a more traditional approach to curriculum design, have responded to the growing market for online education by quickly cobbling together degree programs that combine existing face-to-face elements with new courses developed in the online format (Shelton & Saltsman 2005). Program-level LOA in this context becomes a Rube Goldberg operation of retrofitting curricula with objectives derived after the fact from existing courses developed by individual faculty—with inevitable gaps and contradictions. Learning objectives in individual courses may be presented out of sequence. Some program-level outcomes may not be supported by sufficient learning experiences for students. In addition, course-level assignments and assessments originally designed for the face-to-face environment may not be ideal for an online classroom, making it more difficult to identify which program-level adjustments should be made in response to assessment data.

A more efficient and effective scenario would be a curriculum in which outcomes and assessments are built in from the beginning. Competencies could then be sequentially developed and reinforced within courses and across the student experience, with assessments and feedback deeply embedded and intertwined in each stage of learning. An example of this approach to curriculum redesign was recently undertaken by the Undergraduate School at the University of Maryland University College in its Supporting Educational Goals for Undergraduate Excellence (SEGUE) project. The SEGUE process transformed the undergraduate curriculum, making it more relevant, sequenced, and focused on learning outcomes (Stiehl & Lewchuk, 2008). Applying this process to connect individual courses to programs of study, the undergraduate faculty created seamless learning pathways in 33 programs of study by answering this question: What do we expect students to be able to do "out there" as a result of the learning experiences we offer them "in here" in our curriculum in the Undergraduate School?

Program outcomes were focused not only on the workplace but also on the community, the family, and global society. As a result of SEGUE, faculty have a better understanding of the program in which they teach, its intended outcomes, and what students in their particular course must master to reach intended learning outcomes. Also as a result of SEGUE, students are better able to see the connections between their courses and the contributions of each course to their overall education, their career, and their role in society.

Changing Roles for Faculty

If our assertions here are correct, the distinction between online courses and face-to-face courses will continue to blur. We foresee that day when no course will be entirely face-to-face without at least some online practice and assessments. At many institutions, face-to-face courses use the same CMS software to complement traditional class sessions already; at others, such as the University of Maryland University College, the process has gone further, with all previously face-to-face courses now being taught only as "hybrid" or "blended" format courses (a hybrid or blended course is one in which online course activities replace a portion of the course's official "seat time").

As this blurring continues, the key group with a significant impact on institutional LOA efforts will be faculty. Without faculty support and engagement, these changes simply cannot occur. To be effectively deployed on a large scale, these promising approaches will require a profound transformation in how faculty members interact with students as well as how faculty create and improve curricula and programs. Perhaps the greatest conceptual shift for faculty to absorb will be the new reality that the effective teaching of each student "takes a village" and that the individual instructor in isolation can no longer achieve this. The "classroom walls" of the online course will become increasingly porous, with library staff, course designers, and various other support staff creating, maintaining, and continually improving the learning experience for students (Neely & Tucker, 2010). The new technologies and approaches to online assessment only accelerate a process that has marked online learning programs from the beginning, particularly those programs with large enrollments and students and faculty dispersed across the nation. While demands of scale and cost dictate the sharing of responsibility for course content and instruction for larger online programs, creating and upgrading the learning environment already rests with a network of staff and systems. What has changed with the emergence of new technologies and approaches such as learning analytics is that we are now able to make informed interventions on students' behalf *during* the semester, not just before the next one.

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Conclusion

Redesign efforts to create "programs that learn" will push us further away still from the comfortable and thus-far dominant model of the instructor who has mastered a discipline and who imparts his or her knowledge either through lecture or class discussion. In this new world of higher education, rather than delivering prepared lectures to all students regardless of their foundational knowledge, the instructor's role will be to monitor students' progress and to intervene appropriately when students are unable to advance to the next stage in the curriculum. Instead of the instructor transferring knowledge to students, the instructor (along with learning experts) will develop learning environments with content designed for students in ways that align with best practices. As students work through material delivered online, the role of the instructor will not be to teach all topics to all students but, rather, to monitor which students are having trouble mastering which concepts, so that specific help can be provided to those students at the right time. Faculty roles in pre-semester preparation and post-semester adjustments are changing as well. In outcomes-based program design, course materials and assignments will be delivered based on learning research, not simply on how an instructor wishes to deliver the content based on his or her own past experience.

Course curricula, assignments, and infrastructure will be designed ahead of time, with a tight integration of learning outcomes in all aspects of the course. The difficulty and rigor of assignments will also be set and refined by collective efforts and a shared model of how students learn, rather than by each individual instructor's idiosyncratic practice.

Emerging technologies and approaches in online education enable all instructors to practice what the very best teachers have always known: that students are enabled or limited by their prior knowledge (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010) and that the fine art of teaching involves discovering the multiple pathways that will move students from where they are to the desired learning outcomes. If a student comes to the course knowing a great deal already, the online instructor will be able to assist that student to accelerate the time to completion in a course. If another student needs more help and time to acquire needed prior knowledge and skills, the instructor can augment the student's learning to fill in some of the basic knowledge required before moving forward. While these features could, of course, be integrated in an online course designed by an individual instructor, the truth is that most faculty simply do not have the time, resources, or expertise to recreate what can be integrated far more simply into course management systems for online education.

There will be some who find the seeming loss of faculty autonomy in this new world of higher education profoundly disturbing. Such voices will likely be widespread and, particularly for traditional institutions without extensive experience with online courses and programs, may present a barrier to adopting the new technologies and approaches examined in this paper. Other faculty members, however, will welcome a work environment in which their time is not consumed by preparing learning materials and grading student work. They will embrace the opportunity to meet students where they are intellectually and to provide individualized assistance benefitting the at-risk student as well as the more advanced student held back by a one-size-fits-all approach.

Emerging technologies and approaches in online education enable all instructors to practice what the very best teachers have always known: that students are enabled or limited by their prior knowledge and that the fine art of teaching involves discovering the multiple pathways that will move students from where they are to the desired learning outcomes.

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Comments and questions about this paper should be sent to sprovez2@illinois.edu.

About NILOA

- The National Institute for Learning Outcomes Assessment (NILOA) was established in December 2008.
- NILOA is co-located at the University of Illinois and Indiana University.
- The NILOA web site went live on February 11, 2009. www.learningoutcomesassessment.org
- The NILOA research team has scanned institutional websites, surveyed chief academic officers, and commissioned a series of occasional papers.
- One of the co-principal NILOA investigators, George Kuh, founded the National Survey for Student Engagement (NSSE).
- The other co-principal investigator for NILOA, Stanley Ikenberry, was president of the University of Illinois from 1979 to 1995 and of the American Council of Education from 1996 to 2001. He is currently serving as Interim President of the University of Illinois.
- Peter Ewell joined NILOA as a senior scholar in November 2009.

NILOA Staff

NATIONAL INSTITUTE FOR LEARNING OUTCOMES ASSESSMENT

Stanley Ikenberry, *Co-Principal Investigator*

George Kuh, *Co-Principal Investigator and Director*

Peter Ewell, *Senior Scholar*

Staci Provezis, *Project Manager and Research Analyst*

Jillian Kinzie, *Associate Research Scientist*

Natasha Jankowski, *Associate Project Manager and Research Analyst*

Gloria Shenoy, *Research Analyst*

Gianina Baker, *Research Analyst*

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National Institute for Learning Outcomes Assessment

For more information, please contact:

National Institute for Learning Outcomes Assessment (NILOA)
University of Illinois at Urbana-Champaign
340 Education Building
Champaign, IL 61820

learningoutcomesassessment.org
njankow2@illinois.edu
Fax: 217.244.3378
Phone: 217.244.2155