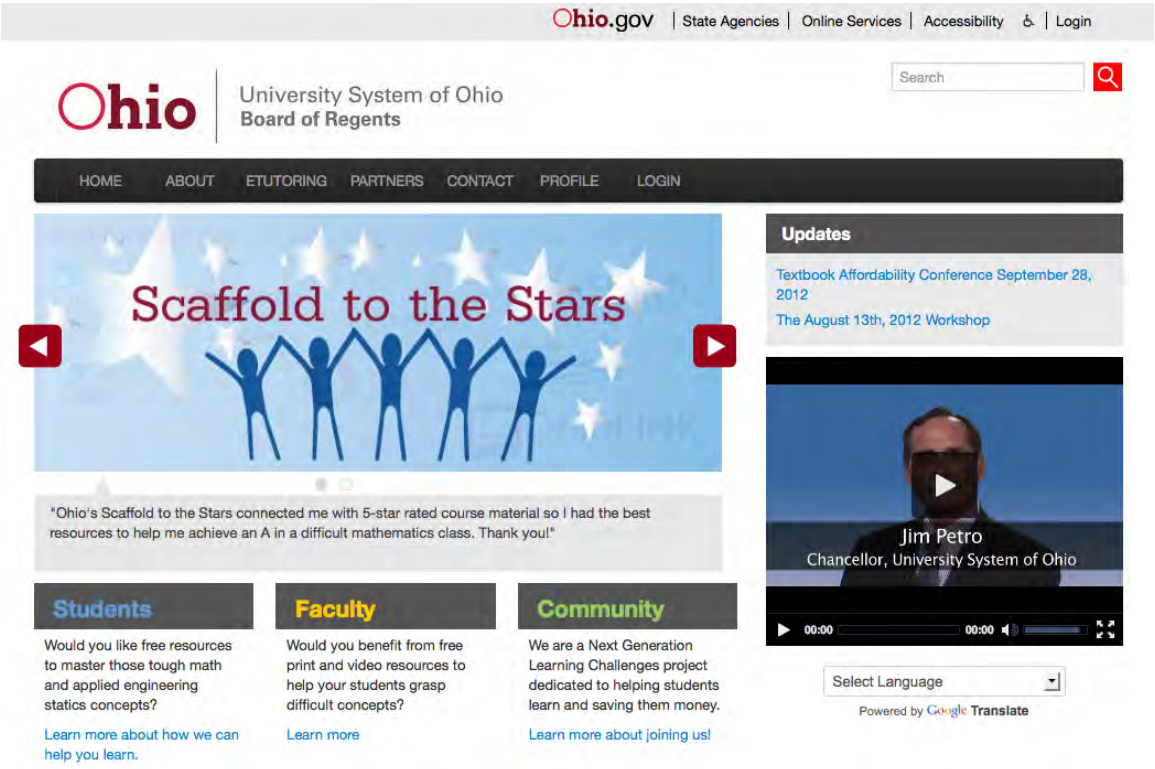
Final Report

Ohio's Scaffold to the Stars
An Educause Next Generation Learning Challenges Project

OhioLINK (Principal Investigators John Magill and Gwen Evans)



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Ohio's Scaffold to the Stars: A Constellation of Insights

Executive Summary

Ohio's Scaffold to the Stars is one of 29 projects funded in Wave 1 of Educause's Next Generation Learning Challenges (NGLC) Program. The unifying theme of the NGLC program is to explore innovations and practices that can lead to the transformation of higher education, particularly in the service of low-income students. This report presents what we have learned, and the data and experiences from which we have drawn our conclusions.

A database of more than 460 open educational resources was constructed and indexed to specific learning outcomes taught in math and statics courses. These resources were created, identified, and introduced into classes at seven Ohio Community Colleges. Together, they provided 73 sections of 48 unique classes with OER resources; 22 faculty members taught more than 1,400 students over four academic terms.

In aggregate, students saved over $100,000 by using customized course materials available for free download under perpetual access, Creative Commons, licenses.

Nearly universally (97%), students indicated they appreciated faculty and institutional sensitivity to their financial concerns. Both faculty and students benefitted from the flexibility of OER to meet different learning styles and curricular requirements without adding additional costs for course materials.

Scaffold to the Stars developed an interface that shows considerable promise to deliver math-oriented open educational resources to blind, low-vision and dyslexic students; an important contribution to supporting universal access to STEM content.

Students in the Statics courses used project-funded 3-D printers to produce three-dimensional objects programmed from mathematical algorithms, a motivational initiative that targets employment in the Next Generation Manufacturing Economy.

In the majority of cases, no statistically significant differences were found between whether student cohorts used OERs or traditional commercial materials and the dependent variables of course completion, grade performance, and retention. Small class sizes, relatively insensitive assessment instruments, and most importantly, differences among faculty, their classes, and institutional characteristics reduced the statistical power of the analyses. Differences favoring OER were found when faculty had had experience adapting the content to their teaching practices, suggesting the important role of pedagogy in mediating the learning outcomes associated with OER.

OER resources will form the bases of the entire Liberal Arts Math curriculum at one of our participating Community Colleges and was adopted as the primary learning resource at one of the largest Psychology courses offered in Ohio. The resources will be available in iLearnOhio, a statewide repository of content and on-line courses.

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Ohio's Scaffold to the Stars: A Constellation of Insights

Introduction

Ohio's Scaffold to the Stars is one of 29 projects funded in Wave 1 of Educause's Next Generation Learning Challenges (NGLC) Program. The unifying theme of the NGLC program is to explore innovations and practices that can lead to the transformation of higher education, particularly in the service of low-income students. This report presents what we have learned, and the data and experiences from which we have drawn our conclusions. We begin by describing the project, listing highlighted outcomes, and then discuss specific characteristics of our innovation that encourage and inhibit broader adoption.

Background and Project Synopsis

OhioLINK, a consortium of 98 higher education and public libraries operating in the state of Ohio, served as Principal Investigator of the Ohio's Scaffold to the Stars grant. OhioLINK initially partnered with five Ohio community colleges- Edison Community College, Lakeland Community College, Lorain County Community College, Sinclair Community College and Southern State Community College. Over the life of the grant, Belmont Community College and Columbus State Community College joined the project.

The project team built a database of open educational resources (OER) to be used by students taking a sequence of math courses and Applied Statics courses. Open educational resources are offered under Creative Commons licenses so they can be re-used, revised, re-mixed, and re-distributed in flexible ways among these courses. In digital form, OER resources can be offered at no cost, and when printed can be provided at very low cost to students.

The OER cost structure is a clear benefit to all students, especially low-income students. For example, a primary resource used in this project- *PreCalculus*, an OER textbook written by project team members Carl Stitz and Jeff Zeager, was offered as a free download from http://stitz-zeager.com and also made available as a 600-page black and white print textbook for under $20, including bookstore mark-up. OER licenses do not expire, so students are able to build personal libraries of content to serve them throughout their higher education endeavors.

The Stitz-Zeager book was broken into modules aligned with learning objectives shared by common math courses taught throughout the state. More than 400 other OER resources were discovered and added to the Scaffold database. The resources served math courses starting at the Developmental Math level and "laddered-up" to Calculus. Students in Statics, an entry-level course in Applied Engineering, had access to these "pure" math resources, as well as engineering-oriented Statics resources. A follow-up applied engineering course in Thermodynamics was also supported with OER content. The "scaffold" guided student progress up this ladder by providing concept-based and applied learning materials. Faculty selected resources and built modular course packs suited to diverse students with different

levels of preparation and different learning styles. The ability to offer personalized options to all students in a class is a key benefit of cost-saving, freely-adaptable OER. This characteristic of OER is sometimes referred to as "mass customization" (Dolence & Norris, 1995).

These modular resources were found and evaluated by a community consisting of 17 math faculty, five statics instructors, and one librarian trained in OER discovery. This community met four times face-to-face during the project's lifetime. From the initial get-acquainted meeting in July of 2011 through the final project meeting of November 2012, these individuals shared resources, teaching practices, and problems and solutions for teaching their subjects using OERs customized for their specific courses.

The stated goal of NGLC is to transform higher education. To seek that radical a level of change, Ohio's Scaffold to the Stars focused on the dimensions of college affordability, personalized learning, and communities of practice that leverage and share individual expertise. To date, the transformation of Ohio's higher education system has not occurred, but a substantial foundation for future change, higher rates of college completion, and collaborative approaches to teaching and learning has been laid. In spite of our collective sense of urgency, transformation is a multi-generational process. Change begins with innovative faculty practicing new methods. Student voices, demanding that institutional policy and procedures support these innovations to deliver more effective and efficient learning, ultimately bubble-up as the drivers for transformation.

Project Outcome Highlights

Ohio's Scaffold to the Stars provided 73 sections of 48 unique classes with OER resources; 22 faculty members taught more than 1,400 students over four academic terms.

In aggregate, students saved over $100,000 by using customized course materials available for free download under perpetual access, Creative Commons, licenses. In 2010, the average new list price of mathematics textbooks used in Ohio's 46 public colleges and universities was $160. At an average price increase of 12 percent per year, this average list price reached $201 by 2012. Books supporting Statics courses were slightly more expensive, on average $180 per book in 2010 and reaching $226 in 2012. Over the life of the project, the *net-cost-of-use* of the average textbook in the typical class was calculated as $87 (net-cost-of-use reflects the average cost of the mix of new texts, used texts, sold-back texts, borrowed texts, and rented texts used within a class of students). The net-cost-of-use of our OER resource sets remained constant across the four academic terms at $12, reflecting a mix of printed (cost-recovery) and downloaded (free) resources. Total student savings garnered in the project were calculated at $105,000 [1,400 students x ($87-$12)]. These savings increase each year if the gap between the net-cost-of-use of traditional commercial resources and OER continues to widen.

A database of more than 460 math and statics resources was constructed and indexed to specific learning outcomes taught in math and statics courses.

Nearly universally (97%), student survey responses indicated they appreciated faculty and institutional sensitivity to their financial concerns. More than half of all students accessed more than a single resource per topic, benefitting those who sought deeper understanding or alternate explanations of course content.

Students in the Statics courses used project-funded 3-D printers to produce three-dimensional objects programmed from mathematical algorithms. The purpose of this exercise was to illustrate the linkage between abstract math concepts and engineering practices related to employment in re-vitalized manufacturing-based economies (See Appendix D).

In the majority of cases, no significant differences were found between whether student cohorts used OERs or traditional commercial materials and the dependent variables of course completion, grade performance, and retention. These NSD finding aren't claiming equivalent learning outcomes, only that learning outcome differences between traditional and OER class outcomes did not achieve statistical significance. Small class sizes, relatively insensitive assessment instruments, and most importantly, differences among faculty, their classes, and institutional characteristics reduced the statistical power of our analyses. Differences favoring OER were found when faculty had had experience adapting the content to their teaching practices, suggesting the important role of pedagogy in mediating the learning outcomes associated with OER.

Scaffold to the Stars developed an interface that shows considerable promise to deliver math-oriented open educational resources to blind, low-vision and dyslexic students; an important contribution to supporting universal access to STEM content.

Community: A Key Construct for Understanding OER Educational Transformation

Organizational innovations are adopted incrementally over time. Organizations with rich and frequent communication around an innovation can adapt and evolve most quickly. In Community Colleges, faculty represent a mixture of full-time and adjunct teachers with much of the communication flowing through administrative channels (the chair) rather than among all faculty. This kind of organizational structure inhibits change when compared to more tightly connected individuals.

Community College students also are often loosely coupled in the classroom, with primary networks tied to the workplace and family. These external demands reduce the time that students spend on campus and consequently limit exchanges among students.

Our challenge was to introduce OER into the Community College environment and then promote awareness and communication among both faculty and students regarding the innovation. In Rogers (1983) terms, we supported *trialability* of OER

by reducing the risk of using them through faculty development efforts and by offering them to students at little or no cost. These experiences would be the bases for communication to help diffuse OER in the curriculum.

Regarding other attributes of Rogers' theory of organizational innovation, we demonstrated the *relative advantage* of much lower costs and flexible sets of learning resources that could benefit students and faculty in many different ways. *Observability* was enhanced through faculty exchanges regarding their teaching experiences and by developing an interface to the resources that allowed students to easily access them.

The attributes that inhibited the spread of our innovation included *complexity* and *compatibility*. Teaching classes with baskets of resources, even when unified by a central OER textbook, is more complex, requiring more planning and divergence in building problem sets and assignments. Working independent of the considerable support that commercial book representatives offer faculty in selecting textbooks, using test files, and preparing class presentations from pre-packaged PowerPoints required changes on behalf of the faculty that were not *compatible* with many of their current teaching practices.

Our overall strategy was to reduce complexity, increase compatibility and support our faculty innovators willingness to embrace the relative advantages offered by OER. In addition to faculty development efforts, the assistance of a librarian in selecting resources, and a $3,000 innovation honorarium, we promoted faculty recognition on their campuses with presentations about the project to their senior administrators and in statewide conferences that showcased their efforts as instructional technology innovators.

Faculty Interviews and the Project Sociogram: A Community Ethnography

We used a structured interview process (see Appendix A) with selected faculty and project members to help evaluate the project from the perspective of participants. The interview questions grew from the discussions we held at four face-to-face meetings that occurred over the course of the project and from numerous problem-solving conversations with individual members of the project team.

Overall, faculty were very positive about their experiences with the project. All felt that expensive learning materials impeded their students learning and that having access to multiple, low-cost resources, rather than only to a single text helped students. Short, instructional video presentations from such providers as the Kahn Academy and PatrickJMT, as well as the practice problem sets provided, were valued. Most respondents recommended a simpler content delivery interface (website) be built and that procedures for adding resources to the database be streamlined. Only two of our faculty reported working with students with print disabilities, but in each case the availability of alternative materials was described as very helpful. 19 of the 22 faculty members indicated an eagerness/willingness to

continue to use OER in their teaching, either as the sole source of content or as supplemental to commercial textbooks they might adopt for future courses.

Chitrakis and Fowler (S*ocial Networks*, 2009) offer another theoretical structure through which to explore diffusion of innovation. They describe four patterns of organizational communication as: *unconnected, bucket brigade, telephone tree*, and *military squad* (see Figure 1). The typical community college learning environment most closely resembles a *telephone tree*, represented below as a student (at center) assimilating information across three separate classes, or as a faculty member (at center) assimilating experiences across the classes he/she teaches. Although the individual student or faculty member is a vital source for introducing new information and innovations within networks, enriching and expanding these organizational communication patterns promote more rapid change.

In contrast to the *telephone tree*, the *military squad* pattern brings community members in closer contact, with both network density and increased communication spurring innovation. A primary goal of our project was to move the community structure more closely toward the military squad formation, reminiscent of college and student communities that described residential colleges perhaps twenty years ago. MOOCs also are moving toward this structure with their emphasis on study groups and peer grading activities (Ng, 2013).

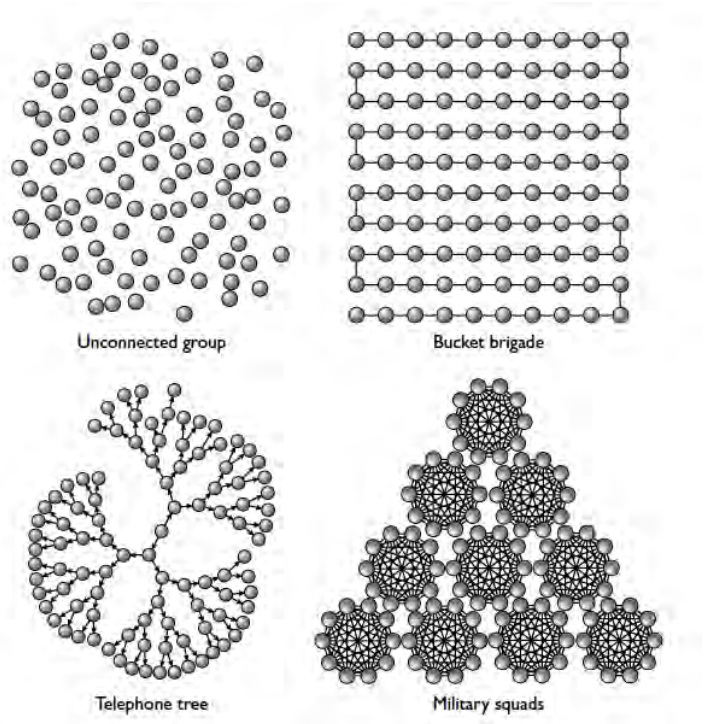


Figure 1. *Four network structures that promote varying levels of communication that correlate to the speed of diffusion of innovation (Chitrakis & Fowler, 2009). A goal of Scaffold to the Stars was to move from the Telephone tree model to that of Military squads. We were partially successful in this endeavor.*

We were very interested in the communication patterns across our project team, since the richness and quantity of communication had been identified as a key construct in promoting OER as an innovation. To visually display this communication, we constructed project sociograms- the patterns of communication within our community. Each member of our project team indicated the five individuals with whom they most discussed Scaffold to the Stars and Open Educational Resources. These individual sociograms were aggregated as a group sociogram that displayed the communication channels among project participants.

The group sociogram indicated that the majority of the communication flowed between project staff and individual faculty members. Campuses with multiple participants showed clustered exchanges on their home campus. The third-order of communication processes portrayed exchanges among faculty teaching the same course on different campuses and were most prevalent for project participants without other colleagues participating from their campus (see Figure 2).

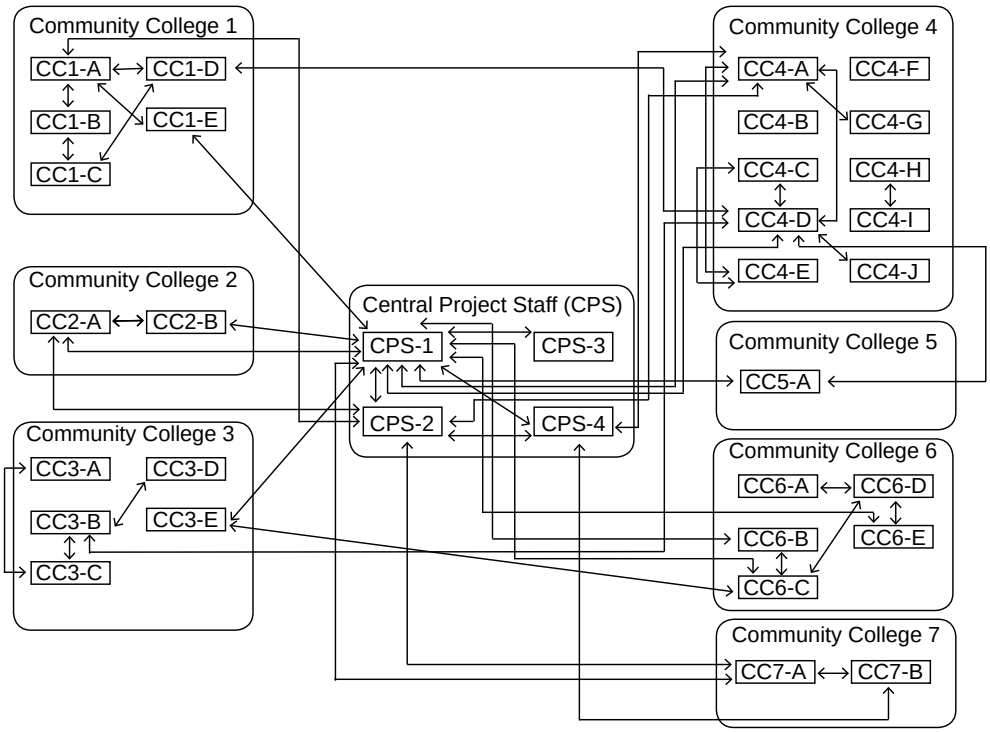


Figure 2. *Six of our seven campuses increased on-campus communication, the Central Project Staff communicated within their group at least weekly, and communication between the center and the seven campuses picked-up markedly over the course of the project. Although we did not fully attain the "military squad" communication that most quickly spurs innovation, the modified "telephone tree" that was established accelerated system communication and resultant change.*

Borrowing from strategies implemented by the NGLC project staff, Scaffold tried a variety of approaches to enrich communication among the colleges and project team to better build community. Listserves and weekly conference calls were not successful, but e-mail "push" digests did promote communication. Our Facebook and Twitter social networking communities developed little traffic; students favored segregating their social and academic networks. E-mail sent to student lists rostered within Learning Management Systems (Blackboard, Angel) was a more successful communication strategy on most of our partnering campuses. In the final six months of the project, we hired a coordinator of distributed group work to manage our eight-node communication network. This position, and the individual who served in this role, proved to be very important in disseminating consistent messages to our project members and improving the timeliness of information exchange.

The Challenge of Discovering Effective OER

Discovering suitable open educational resources is challenging for several reasons. First, many faculty and other potential users are not aware of open educational resources, or the advantages they offer. There aren't legions of publisher representatives stopping by faculty offices with brochures and sample copies to inform faculty members of OER options.

To address this challenge, we created and offered a statewide webinar that originated on the Sinclair Community College campus. This archived resource was augmented by the excellent webinar series offered by the *Community College Consortium for Open Educational Resources* (CCCOER). CCCOER's hour-long webinars feature experienced users of OER resources and address multiple issues experienced by all OER adopters. We also publicized the NGLC *Water Cooler Seri*es (informal chat sessions) offered through Adobe Connect™.

Even after faculty become aware of the licensing, flexible use and pricing virtues of OER, potential adopters still face the often overwhelming need to identify, select, and sequence resources that fit their course requirements. Whether canvassing MERLOT, Connexions, Orange Grove, or other OER repositories, there are too many choices facing time-stressed faculty. Without help, many faculty default to the status quo and continue to use commercial content.

Scaffold added an intermediary to the resource selection process- a librarian skilled in the discovery process. Participating faculty provided their course syllabus to the project librarian. Using an instructional focus for the "pathfinder" process commonly used in research, the librarian found a set of OER resources indexed to the learning objectives represented in the syllabus. The instructor then evaluated this array of resources, and selected those that fit her/his teaching style. The course builder module that is part of the Scaffold interface then sequenced the content in a course calendar and presented the course pack to the students.

The final step in validating discovered resources was to provide a star rating system for both faculty and student users. Supported by a comments field, these ratings can

be translated into rankings such that faculty would have a starting point based on the history of their colleagues reviews balanced by student "crowd sourcing." Together, these two ratings help newly adopting faculty identify student-friendly content that meets course learning objectives. In our experience, the rating stars did help faculty select content, though the number of faculty ratings was low. Student ratings (n=307) equaled 4.02 on a 5-point scale. However, to be most effective the rating system needed to have captured more student comments (see Figure 3).

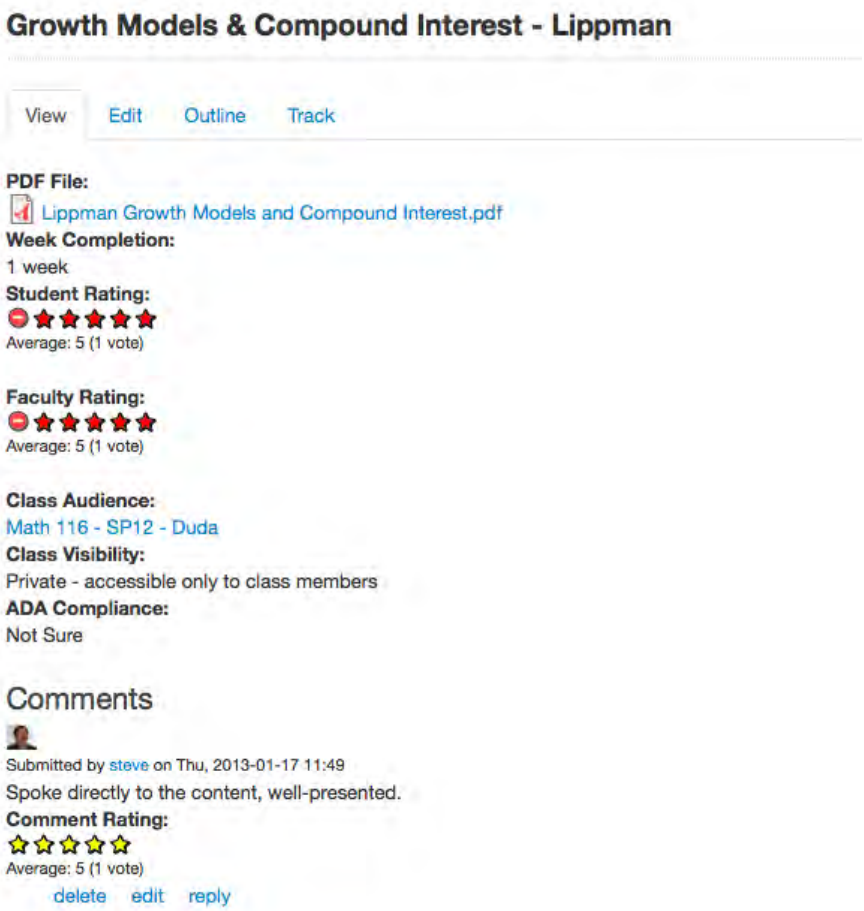


Figure 3. *Faculty and student comments assisted future faculty in selecting materials. ADA Compliance was a searchable metadata field useful for building alternate modular course packs.*

Scaffold to the Stars is named for the ascending hierarchy of math concepts and the support offered to build competencies. From Developmental Math to Calculus, the skills associated with each level must be mastered to move to the next math course. In most cases, those resources associated with Algebra, Trigonometry and Pre-Calculus are indexed to these competencies and further described by the four most-used metadata fields from the Dublin Core Enhanced Metadata- Title, Source, Author, and Publication Year. Faculty could search on these four metadata fields. We also tagged resources with a searchable *accessibility* metadata field, to be discussed in a later section of this report.

A number of challenges exist regarding resource search, over-and-above those associated with discovery (Dempsey, 2012). The metadata scheme for competencies was generated from two sources- the transfer and assurance guidelines developed by Ohio math faculty that describe content in common subjects taught across Ohio college and universities, and learning outcomes tied to the Pre-Algebra textbook authored by John Redden (2011). This taxonomy-building approach was a necessary compromise because there are no competency definitions constructed for Developmental Math courses in Ohio.

Pieces, Parts, Projects, and Programs

Large, distributed projects are leveraged at each stage of aggregation- small positives and small negatives are multiplied and amplify effects as the innovation moves from individual faculty member toward system-level adoption. Positive effects include sharing problem sets and solutions across math faculty who can double-check for accuracy and clarity. Similarly, faculty training ideas learned by early participants benefitted those who came later to the project. A number of student engagement ideas (require resource ratings from students, draw quiz questions from multiple sources, offer extra credit for time-on-task) were confirmed and reinforced within the community.

Negative effects are also amplified up the hierarchy of change. Each project participant has personal goals and predilections that are nested within the goals and needs of their organization. The alignment between personal and organizational goals is critical to achieving project goals. And, at the highest level of this need pyramid is program objectives— how do multiple projects intertwine to achieve programmatic goals? To achieve program goals, the goals of individuals, their institutions, the project as described to the funder, and the overall programmatic needs must overlap and remain aligned over the life of the project.

To better coordinate information so that it served all levels of this hierarchy, the Scaffold project added a distributed group communication coordinator to the project team. Her principal role was to exchange information with the distributed campuses and individuals in a form that served the Scaffold project.

When system level priorities or personnel change, challenges to achieving project objectives escalate. Those new to programs and projects are less likely to understand the intricacies and relationships that exist in ongoing projects, and can inadvertently impede and delay the progress of individual projects. Priorities and practices that are still fragile in the virtual project organization are especially susceptible to changes in programmatic vision that misalign program and project objectives. Because of large-scale re-organization among state agencies and personnel, this alignment changed in the middle of our project. In spite of the best intentions of all involved, this flux predictably lessened achieved project outcomes.

OER- The Challenge of Accessibility

Accessibility requires that the platform from which content is offered is accessible, as well as that the available resources served from the platform are accessible. In its latest iteration, Scaffold to the Stars was built on the open source Drupal platform and incorporated an accessibility view to serve low-vision, blind, and dyslexic students. Scaffold served as the prototype for a number of re-designed websites to serve Ohio Board of Regents and Ohio Government needs (see Figures 4 and 5).

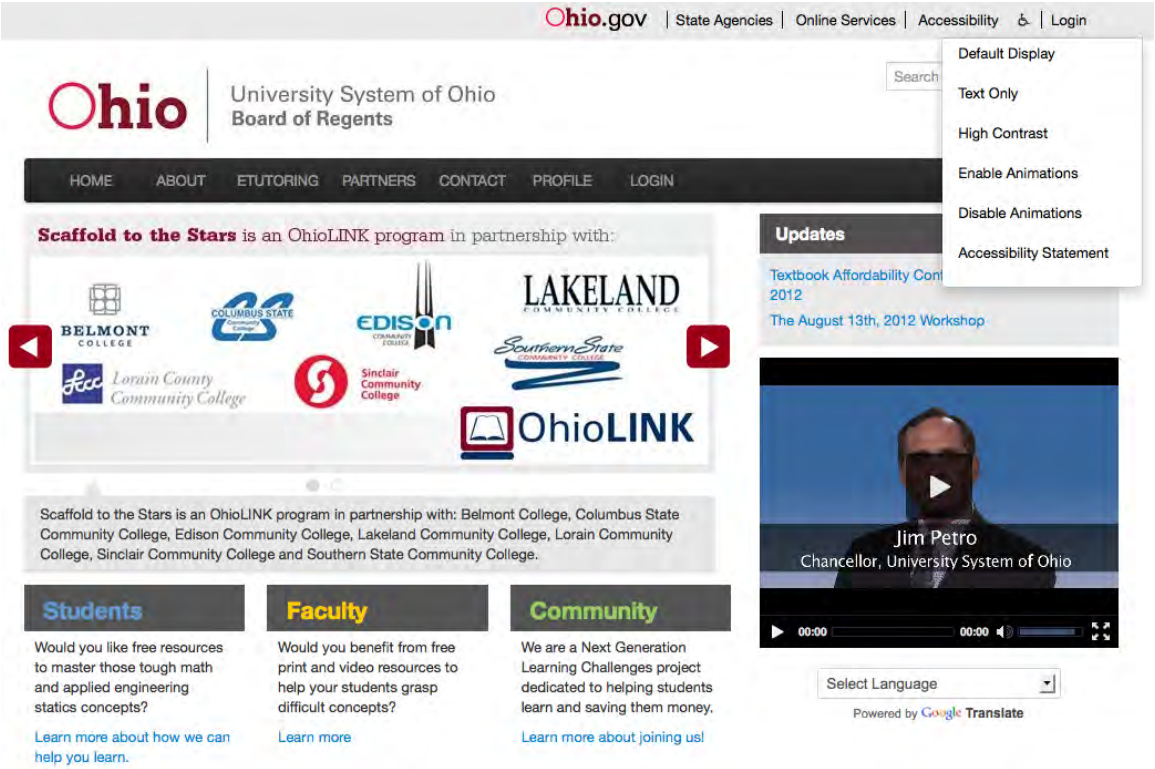


Figure 4. *The Drupal-based Scaffold website featured a high-contrast and text-only rendering of the interface to meet accessibility requirements—note the pull-down menu in the upper right corner of the interface. In addition, content resources were tagged as "accessible," "not accessible," or as of "unknown" accessibility by the contributor. Given a repository of multiple resources, faculty could craft accessible content as needed by students with print disabilities.*

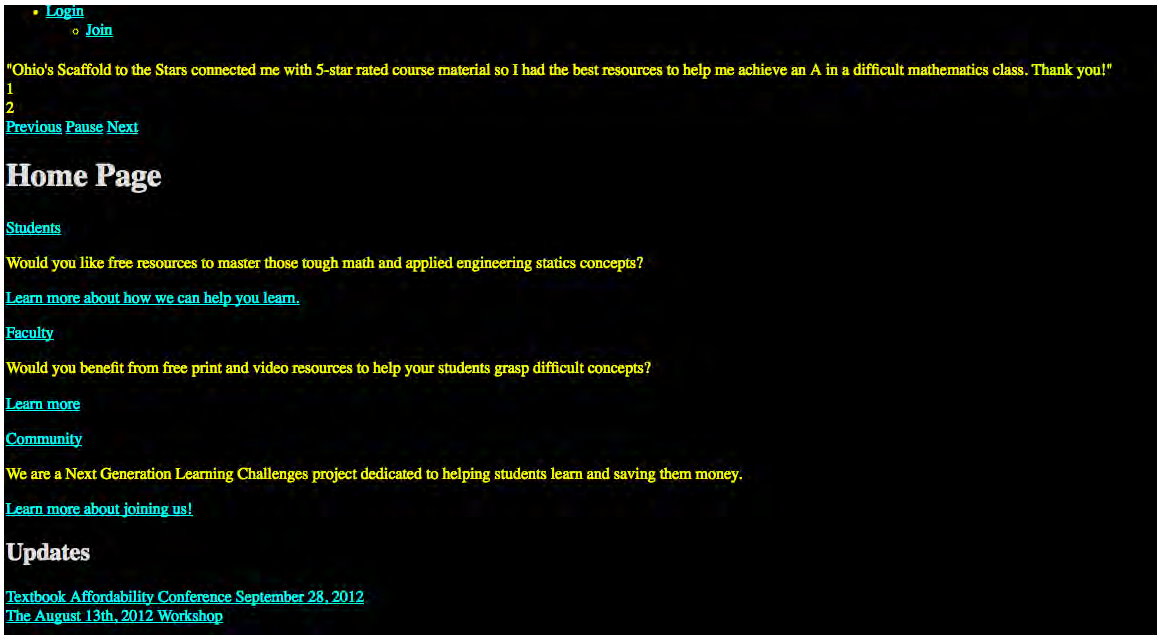


Figure 5. *The high-contrast, text-only version of the Scaffold Home Page is a display option to serve students with print disabilities. Universal access is a requirement for innovations to diffuse broadly in educational settings.*

In the realm of content, some practitioners separate the OER universe into resources created and shared by organizational "authors" and individual authors. OpenStax and CK-12 are organizational, "professional," providers of OER. Both OpenStax and CK-12 are typified by multiple review/editing processes for accuracy and have procedures in place to address accessibility concerns. Until a recent change in business model, Flat World Knowledge would have fit this category and their partnership with Bookshare offered an excellent example of an organization-wide focus on accessibility.

In contrast, individual authors working alone create a very large percentage of OER content. These individuals are motivated to share their work, but not necessarily to edit it or assure its accessibility. Indeed, many of these faculty authors are unaware of the importance of assuring universal access to their materials, and if they are aware, do not have the skill to convert the content so that it is available to students with print disabilities.

Scaffold addressed the accessibility challenge by including in the Drupal-based version of the interface for adding resources an accessibility metadata field that allowed a contributor to indicate the resource was accessible, was not accessible, or the author did not know its accessibility status.

By foregrounding accessibility, our project intended to increase faculty awareness of the importance of accessibility, provide a mechanism for a system-level support person to convert content to accessible resources, and to provide those who offered courses based on OER a mechanism for aggregating modular resources into packages. This labeling assists faculty in preparing course packs that result in

equivalent learning outcomes for the cohort of students with print disabilities and those who don't exhibit this characteristic. Faculty and institutions have recourse to meet their ethical and legal obligation to provide a learning environment that offers "equal outcome for equal effort," an expensive and difficult to accomplish outcome when resources are offered under traditional copyright conditions. Acker and Petri (2012) offer a broader treatment of this requirement in their Accessing Higher Ground conference presentation.

Whether resource packs can be constructed to provide "equal outcomes for equal effort" can be modeled with the Google Analytics™ flow diagram (see Figure 6).

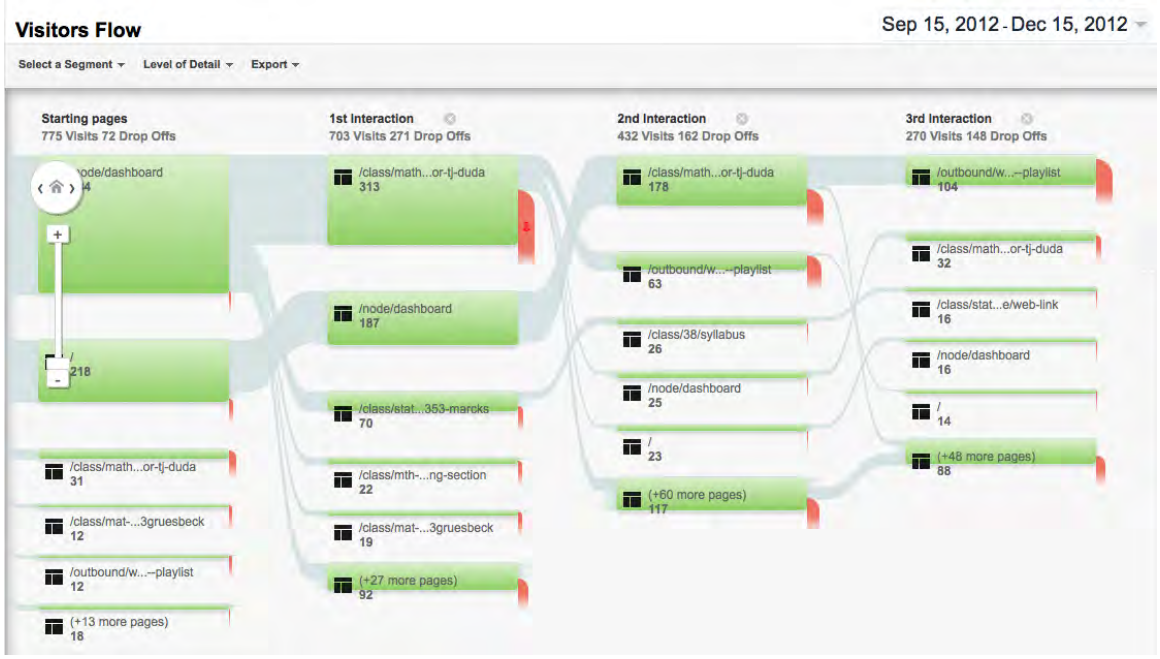


Figure 6. *By tracing "flow" (sequence) through different "funnels" (web pathways) it is possible to trace two different learning paths to "fulfillment" (desired outcome). In our case, fulfillment is described as achieving a particular learning outcome. If time devoted to each of the pages and for each of the interactions are roughly equivalent for a standard funnel and a fully accessible funnel, a curriculum designer can tune a resource pack for those students with print disabilities.*

OER- The Challenge of Interface

As discussed earlier, Everett Rogers identified both *relative advantage* and *compatibility* of an innovation as correlated with adoption. Relative advantage describes the attribute of permitting an adopter to do something better, more easily, with fewer resources, or a combination of all three. Compatibility describes an innovation that is consonant with the way an adopter currently operates, or is consistent with their typical practice or value structure. Compatibility can reinforce, or be at odds with, an innovation's relative advantage.

In our case, the Scaffold interface evolved over the 18 months of the project. The initial interface was flexible and well-understood by Lakeland Community College

and other partnering institutions that used it early in the project's evolution. This interface, essentially a text-only, link-based, database presentation was simple to use, indexed to learning objectives, and *compatible* with many current faculty practices. On the other hand, the interface was lacking in relative advantage- the most popular browser (Internet Explorer™) could not access the interface, the interface was not accessible, the log-in procedures were inconsistent, and students had to go to an external URL to find and use the resources (See Figure 7).

Click the links below to learn more about

Graph points on a real number line.

Resource	Rank	Resource Type	Rate this Resource (*Why?*)
Points on a number line : U09_L1_T3_we2 Points on a number line	☺	video	Rate this resource
Stitz-Zeager Precalculus Section 1.1 Review	☺	PDF	Rate this resource

The rank is based on the ratings from students and instructors! Please vote, after you have used the resource!

Figure 7. *The original Scaffold interface was simple to use, indexed to class resources, and compatible with current practices on the Lakeland Community College campus. However, for this version of the interface, log-in was inconsistent, security limited, not accessible, and incompatible with the latest versions of the Internet Explorer™ browser. In this case, relative advantage and compatibility were at odds.*

The second iteration of the interface placed the resources as an indexed list within the Blackboard™ LMS, which is in use on the majority of our partnering campuses. This second iteration provided secure access, a known log-in URL, and the potential to better track usage. However, a focus only on Blackboard™ would result in a system optimized for an LMS that serves only 51% of the overall market (Campus Computing Survey, 2012).

As their content interface, Belmont Community College used the Jenzabar™ LMS, and this LMS was not well-adapted for use in our project. As an alternative, Belmont organized the Scaffold resources within LibGuide™, an interface familiar to the library-oriented members of our Scaffold project team (See Figure 8).

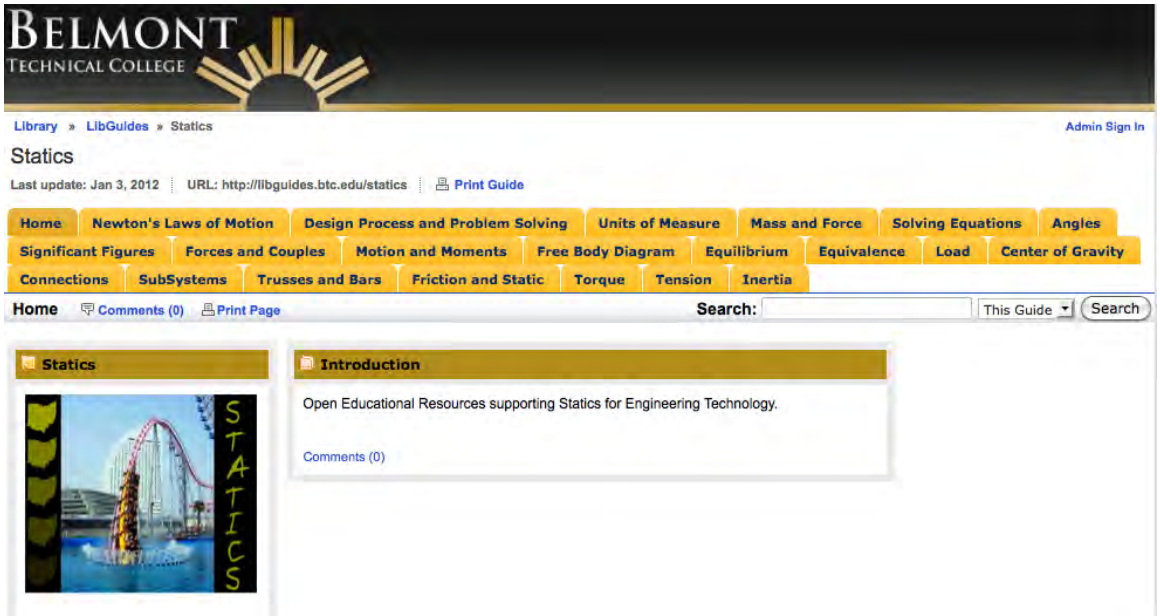


Figure 8. *LibGuide™ is popular in the Library community and is intuitive and easy to use. However, the interface, shown here for our OER statics resources, lacks individual user tracking and accessibility features.*

Although LibGuide™ is easy to use and compatible with the library community, the lack of individual user tracking and accessibility features in the interface limit broad deployment. Further, dividing the community up among the prototype Scaffold interface, the Blackboard™-enabled interface, and LibGuide™ spread limited technical resources across three different interfaces. This division of labor and practice separated rather than unified the project team.

To address these usability and relative advantage challenges, Scaffold next moved to a Drupal-based interface with decided benefits. The interface was accessible, based on a popular and well-supported open source platform, compatible with analytic software and protected by secure log-in. However, these relative advantages were offset by challenges to compatibility, or use practices in place on some of our campuses (See Figure 9).

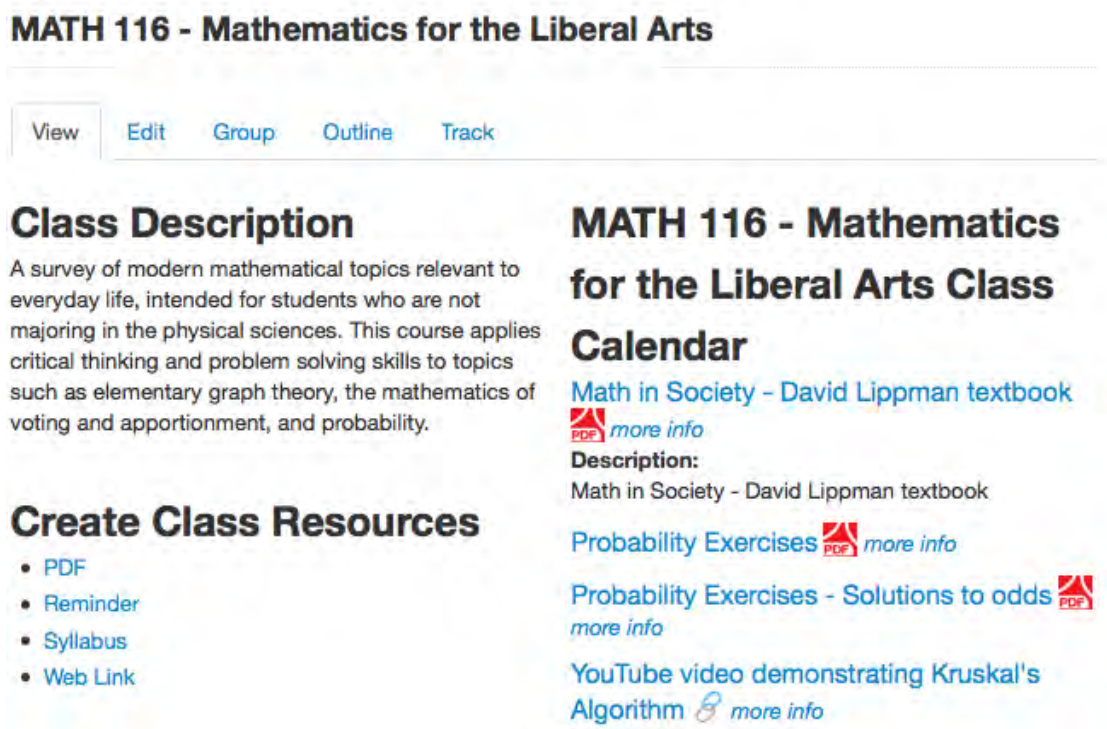


Figure 9. *The Spring 2012 Drupal interface offered strong security and accessibility. However, the interface was incompatible with some campus resource-building practices and lacked folder structures to encourage resource sharing among faculty.*

To address these compatibility concerns, mainly an inability to group and share resources in convenient folder structures, a software group was hired to add these features to the first generation Drupal-interface such that the interface's relative advantages could be combined with the compatibility features required by our user base. Unfortunately, the software group was unable to introduce these features in a timely manner, and our next lesson learned- academic calendars and project calendars don't always coincide- came into prominence in Autumn of 2012.

Academic vs. Project Calendars- Meshing Conflicting Timelines

The academic calendar is inviolate and the start and finish of academic terms is set years in advance. If an innovation is to benefit students, it has to be available on the schedule dictated by the academic calendar. On day one of a course, students must have a tested, bug-free interface, and be enrolled in the userID database for access. Indeed, to be most effective, the interface that serves instruction should be available well in advance so that the faculty can be familiar with its operation and comfortable demonstrating the interface to their students.

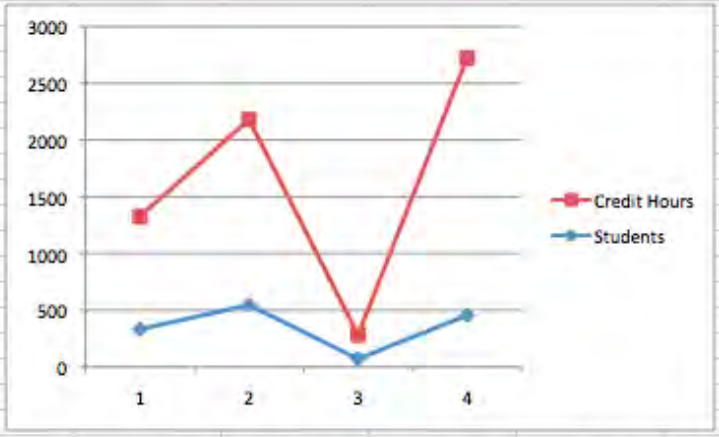
Project calendars are less sensitive to external deadlines; although a more accurate way of saying this is that moving from development, to testing, to production level functionality is of more importance than hitting a specific deadline. On many project timelines, the rollout is simply delayed until the system's functionality has been fully tested and demonstrated.

In many respects, these dueling calendars are irreconcilable—it can be catastrophic to release a flawed system into the academic environment. At the same time, a late release offers no benefits until the next academic term begins. This challenge, needing to roll-out the new Drupal-based interface when it lacked full functionality (requiring work-arounds), had a material impact on what we learned in the analytics realm, described in the next section of this report.

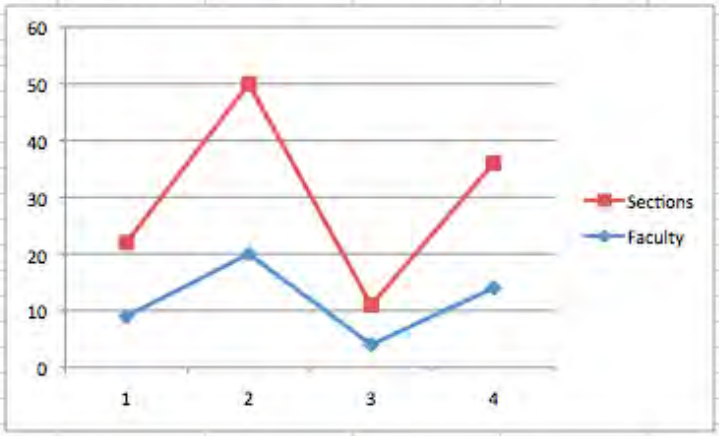
OER Analytics- Overall Use of Scaffold and Learning Outcomes

NGLC requested a variety of measures to document learning outcomes and system use. Our data collection processes involved student learning outcomes measured by grades, course completion, and retention; surveys that presented student use and perception patterns; cost savings tabulation based on "net-cost-of-use" for classes that adopted the resources; and for one term of data collection within a subset of participating courses, the use of Google Analytics to track student use of resources.

Scaffold was introduced in Autumn of 2011 and was used in four academic terms through Autumn of 2012. The total credit hours served by Scaffold increased substantially by Autumn of 2012, partly as a result of the state of Ohio converting from quarters (3 hours per course) to semesters (5 hours per course). This change in the length of the academic term contributed to a reduction in the number of students who enrolled in Scaffold math courses since a full course load resulted in fewer total courses taken per term (See Figure 10). Indeed, overall enrollment in Ohio Community Colleges decreased six percent between the quarter-based and semester-based calendars.



	Fall 2011	Spring 2012	Summer 2012	Fall 2012
Students	331	545	70	454
Credit Hours	993	1635	210	2270



	Fall 2011	Spring 2012	Summer 2012	Fall 2012
Faculty	9	20	4	14
Sections	13	30	7	22

Figure 10. *Student use of Scaffold reflected differences between Autumn and Spring terms and Ohio's conversion from Quarters (3 credit hour classes) to Semesters (5 credit hour classes). The conversion occurred over Summer of 2012 and this conversion had a negative impact on faculty uptake given the time and energy associated with the course conversion process. However, total credit hours increased.*

This total enrollment of 1,400 students was distributed among 7 partnering colleges, math courses that included Developmental through Calculus offerings, and in two different Statics courses, the Applied Engineering Introductory course and an advanced Thermodynamics course. This tremendous diversity suggests caution in interpreting aggregate results since there are a number of sources of variance across institution, course type, course level and instructor. These concerns are particularly significant at the instructor level, each of whom applies individual grading criteria.

Student Perceptions and Use Patterns of Scaffold OER

Student use of Scaffold resources was in a bimodal distribution—36% used the resources regularly or every day and 42% only when studying for a test, seldom, or never. The remainder (22%) reported using the materials "occasionally." Total sample size was 407, representing a response rate of slightly more than 29%.

We had hypothesized that offering diverse materials would benefit students. Sixty three percent used two or more resources; thirty percent used only one and seven percent reported no use at all. Of those who watched the Khan Academy videos (52% of the sample), 70% found them useful or very useful.

Use patterns indicated that a laptop was the dominant access mode; 76% of students reported they had used a laptop to access course materials. Other mobile devices used grew throughout the project- twenty percent of our sample used their phone and nine percent accessed the materials using a tablet computer.

We gathered data on student perceptions regarding the open educational resources as well as educational attainment supported by access to the resources. The perceptions data were based on instruments that we had used in an earlier Flat World Knowledge study, but were extended to reflect the modularity of the resources used and the more customized nature of the resource packages that were created in Scaffold. Appendix B presents the survey instrument provided to students (See Appendix B).

In the final term in which we collected data, we introduced Google Analytics™ into our project. Google Analytics™ offers a powerful approach to evaluating "fulfillment," or purchasing behavior, in commerce. For our purposes, we defined fulfillment as learning outcomes and applied Google Analytics™ to Scaffold usage in a Math for the Liberal Arts course offered at Columbus State Community College. Google Analytics™ offers a variety of useful insights- the source of website visitors, including time spent on any particular webpage; the sequence of web pages different users followed; and the operating systems from which users accessed the site.

Although traffic originated overwhelmingly in Ohio and from our participating campuses, Scaffold was visited from Canada and from nine other states in the US. Approximately 30% of visitor pages began from within a course homepage held within an LMS on a campus. The remainder came from direct access from a link provided on the course syllabus.

We also gained insight into the increasingly mobile aspect of learning; 7.5% of our traffic came from mobile platforms (71% AppleOS and 29% Android). Laptops were the preferred method of visiting Scaffold; 45% of the laptops used the Internet Explorer™ browser, 29% used Firefox™, 14% Chrome, 10% Safari™, and 2% other. These data were particularly helpful since it confirmed that our pilot platform, which did not work with later versions of IE, probably constricted use of the resources, at least via the browser of choice of some of our students. Figure 11 shows some of the insights we garnered from this micro-study.

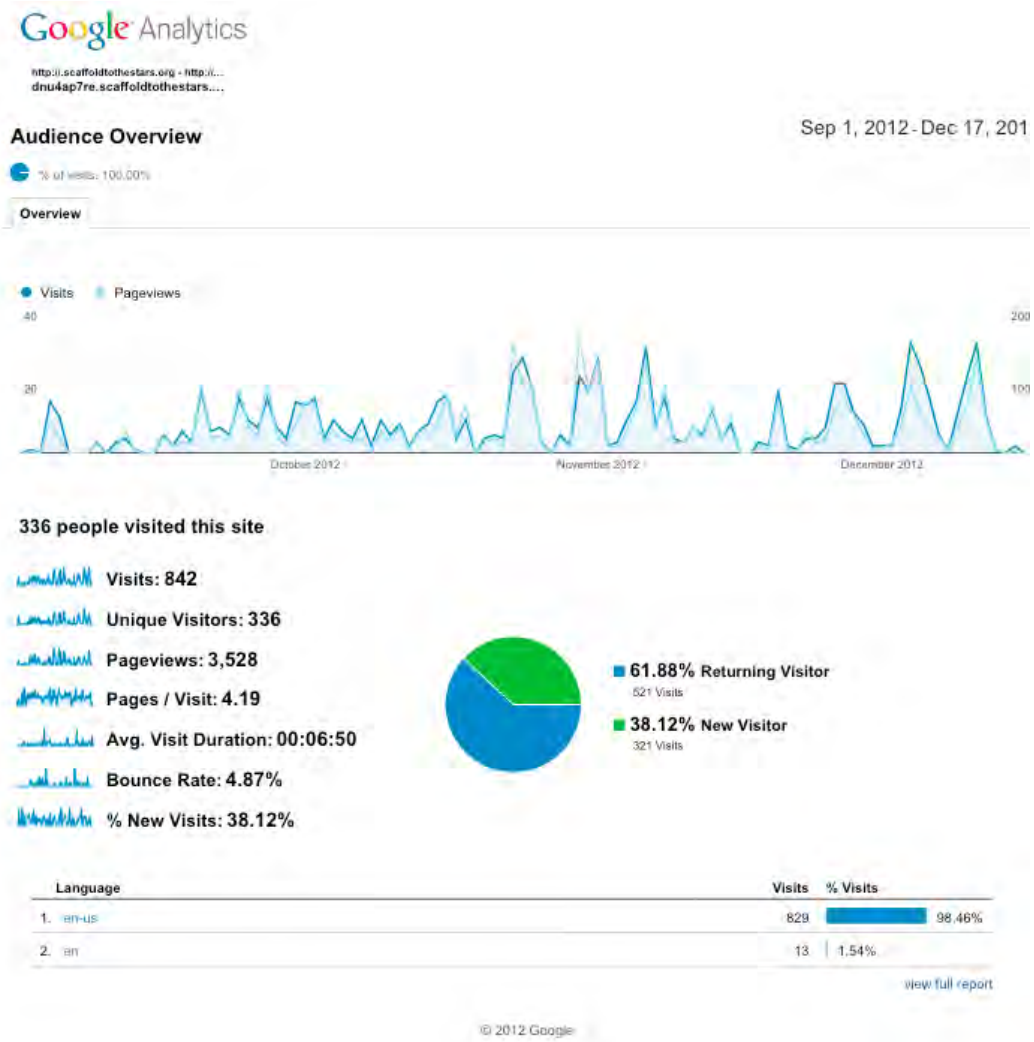


Figure 11. *Google Analytics allowed us to map overall access to on-line resources. The usage pattern confirms data gathered within learning management systems—class meeting days and exam schedules drives use. Content often is consumed in small "snatches" rather than in extended sittings.*

We also constructed datasets that were linked to specific Scaffold student IDs and their usage patterns throughout the academic term. Our goal was to evaluate whether there was a relationship between frequency of access and student performance. However, the data were "noisy," the primary texts for many of the courses were downloadable. Once downloaded, use of the materials becomes un-trackable and confounds attempts to correlate resource use with learning outcomes.

The final contribution Google Analytics™ made to Scaffold to the Stars was to provide a pathway to document a method to demonstrate accessibility. Google Analytics™ defines a "funnel" as the pathway a web-user follows to reach an end state, typically a purchase. The size of the funnel indicates the number of individuals landing on each page in the sequence.

We used the concept of funnel to consider how two different pathways could lead to the fulfillment of learning outcomes, imperfectly measured as grades received in a class. We were interested in whether two different sequences could lead to equivalent learning outcomes. In the case of accessibility, two different populations, those needing accessibility support and those without this need would use two starting pages. If the content modules were equivalent in helping students learn, and if the number of modules visited were approximately the same, we would have data usable to create improved parity of funnels for students with print disabilities and those without (see Figure 12).

Figure 12. *At each step in the path toward fulfillment (learning outcomes), Google Analytics™ permits an instructor to adjust the content offered at each step. Once the fine-tuning has been completed, an instructor has offered approximately equal learning opportunities for students with print disabilities and those without. In the best of circumstance, all content is accessible. Given the difficulties that many content providers have had in delivering accessible materials in STEM, concentrating on assuring full accessibility at each step in at least one learning funnel is a useful strategy to meet the needs of all students.*

Triangulating OER/Math Data- The Scaffold Project within an Overall OER/Math Initiative

OhioLINK and the Ohio Board of Regents have conducted an ongoing textbook affordability/digital access program since 2009. As part of that initiative, we have collected data on students' use and perceptions regarding two affordability/learning outcomes innovations- learning resources created by Flat World Knowledge, a publisher that emerged as a purveyor of "freemium" OER resources, and ALEKS, an individualized, computer-based math program that can be supplemented with a variety of print resources if an instructor so desires. NGLC encouraged us to do a

meta-analysis of these three projects to better inform our understanding of the outcomes of providing Scaffold's OER and low-cost math resources to students and faculty. These results are presented below.

Flat World Knowledge's "Freemium" OER

Flat World Knowledge Publishing (Flat World) and the State of Ohio signed a contract in 2010 to evaluate student use of Flat World resources. At the time, Flat World's business model relied on providing free access to their content from their website, and then encouraging students to purchase premium resources such as flash cards, downloadable PDFs and practice tests. This business model is called "freemium" because it encourages use of free resources and then promotes charges for value-added, premium resources.

The Flat World study confirmed that students were amenable to digital resources if cost savings resulted from the switch. Further, the frequency of costly printing was much lower than what students had expected prior to experiencing digital OER content. Even though printing requirements were less than anticipated, we confirmed the importance of providing flexible print options to meet different student preferences. Consistent with our Scaffold data, students wanted the ability to print, but often in small units targeted around specific content. Providing print as an option resulted in significant cost-savings for students.

Student expectations regarding the Flat World OER content were measured with a pre-survey. At the end of the course, student perceptions were again surveyed. Our goal was to determine whether responses based on *expectations* changed with actual *experience*. Figures 13 and 14 indicate that a slight majority of students strongly agreed or agreed that electronic/digital textbooks were preferable to print, hard copy text books and that these perceptions did not markedly change with actual experience with digital textbooks.

Responses to statement that a student prefers electronic/digital textbooks to copy text books.

Time	Strongly.Agree	Strongly.AgreePct	Agree	AgreePct	Disagree	DisagreePct	Strongly.Disagree	Strongly.DisagreePct
Pre	123	15.11%	310	38.08%	317	38.94%	64	7.86%
Post	121	19.45%	231	37.14%	196	31.51%	74	11.9%

Figure 13. *Students were approximately split on whether they preferred digital or print content when asked before using digital materials and then asked again after using the materials for an academic term.*

Comparison of pre- and post-test responses to statement that a student prefers electronic/digital textbooks to copy text books.

Pretest	Post.Strongly.Agree	Post.Agree	Post.Disagree	Post.Strongly.Disagree
Strongly.Agree	36	16	4	1
Agree	22	76	37	10
Disagree	7	53	72	15
Strongly.Disagree	1	3	15	18

Figure 14. *In part of the overall sample, we were able to collect individual, pre/post linked data. These paired results confirm those of Table 13, and indicate that the preferences became stronger (more polarized) for those who originally preferred digital as well as for those who originally preferred print.*

Figure 15 indicates that the majority of students originally agreed or strongly agreed (79%) that electronic/digital textbooks provide the same level of quality as printed hard copy textbooks, and again the responses were more polarized at the post-test. A greater percentage strongly agreed with the statement at the post-test, and a greater percentage also strongly disagreed (See Figure 15).

Responses to statement that electronic/digital textbooks provide the same level of quality as printed, hard copy text books.

Time	Strongly.Agree	Strongly.AgreePct	Agree	AgreePct	Disagree	DisagreePct	Strongly.Disagree	Strongly.DisagreePct
Pre	150	18.43%	489	60.07%	157	19.29%	18	2.21%
Post	145	24.33%	267	44.8%	133	22.32%	51	8.56%

Figure 15. *The majority of students agreed or strongly agreed that digital textbooks were of equal quality as print textbooks. With experience, student opinions tended to polarize in both directions.*

Figure 16 indicates that students reported that digital resources were more cost-effective than traditional commercial print resources (See Figure 16).

Responses to statement that electronic/digital textbooks are a more cost-effective option than printed, hard copy text books.

Time	Strongly.Agree	Strongly.AgreePct	Agree	AgreePct	Disagree	DisagreePct	Strongly.Disagree	Strongly.DisagreePct
Pre	436	53.37%	342	41.86%	31	3.79%	8	0.98%
Post	343	55.14%	231	37.14%	41	6.59%	7	1.13%

Figure 16. *More than 90% of students indicated that digital textbooks were a more cost-effective option when compared to traditional, print textbooks. Students had the*

choice of reading the digital content at no cost from the website or downloading a digital version of the material for $35.

Figure 17 indicates that students found additional digital learning tools (practice tests, flashcards, topic outlines) benefitted their study. This additional flexibility is a virtue of making multiple resources available to students (See Figure 17).

Time	SA #	SA %	A #	A %	D #	D %	SD #	SD %
Pre	373	45.71%	404	49.51%	34	4.17%	5	0.61%
Post	200	39.53%	251	49.6%	37	7.31%	18	3.56%

Figure 17. *Students valued access to additional digital resources because they provided a broader set of tools to improve their learning.*

Figure 18 indicates that at pre-test students anticipated they would print a large percentage of the materials. However, at post-test, students indicated that a much lower percentage of the content was actually printed (See Figure 18).

Percent of digital materials printed.

Time	Pct.100	Pct.100Pct	Pct.80	Pct.80Pct	Pct.60	Pct.60Pct	Pct.40	Pct.40Pct	Pct.20	Pct.20Pct	Pct.0	Pct.0Pct
Pre	71	8.7%	152	18.63%	170	20.83%	161	19.73%	193	23.65%	69	8.46%
Post	58	9.34%	63	10.14%	59	9.5%	63	10.14%	107	17.23%	271	43.64%

Figure 18. *Students printed far less often than they had anticipated. Nearly 44% of the students printed none of the digital materials made available to them and only 20% printed 80% or more of the digital materials provided. The fact that print was optional resulted in substantial student savings.*

Figure 19 indicates that the mean value (pre $40.75; post 41.95) and standard deviation of student-assigned dollar values (pre $18.57; post $18.18) are almost identical between the pre-test and post-test (See Figure 19).

Summary statistics for fair price

time	mean	sd	min	max
Pre	40.75	18.57	0	175
Post	41.95	18.18	0	125

Figure 19. *Student perceptions of a fair price for digital learning materials were remarkably consistent before and after using the digital materials. In both cases, the perceived fair value of the content was approximately $41. The net-cost-of-use for Scaffold materials averaged $12, significantly below the fair price reported in the Flat World study. Both the Scaffold and Flat World materials were less costly than the net-cost-of-use of traditional commercial content.*

We were also interested in whether faculty experience with digital learning materials resulted in students evaluating the resources more highly. We reasoned that as faculty became more experienced with a particular set of resources, the instructor would develop greater insight into how to make the resources most valuable to students.

There was substantial variability among student perceptions of content value across courses and terms taught by different faculty members. Figure 20 is representative of the variability in our data sets across time of how students perceived the value of the learning materials the first, second, or third time the faculty required them. When innovations are new to both faculty and students, and as the attributes of the use of innovation are perceived as unstable, it is dangerous to draw unqualified conclusions. Rather, it is more prudent to consider the analyses as exploratory rather than supporting any generalized hypothesis (See Figure 20).

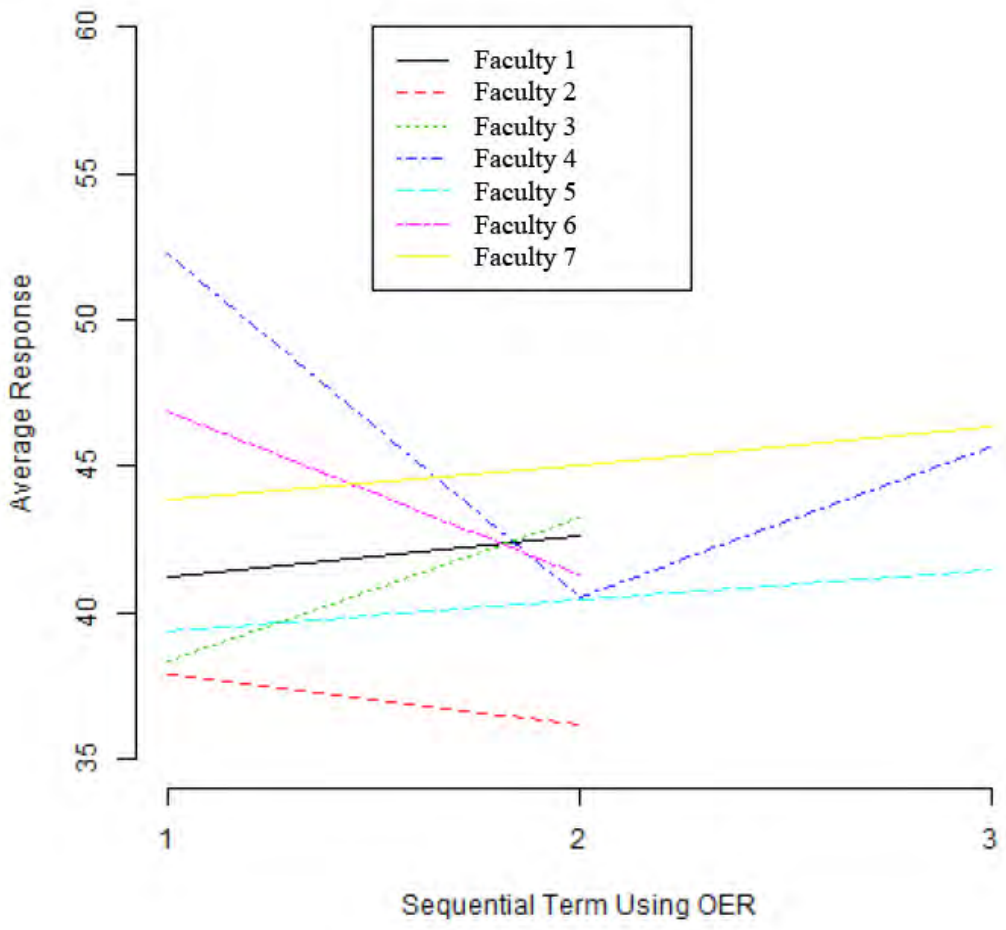


Figure 20: *This figure represents the dollar value students assigned to the textbook/digital resources the first time, second time, and third time different instructors used the content. Results within instructor as well as over time varied. Relatively small class sizes, typically between 12 and 30 students, and different teaching approaches used by different faculty members contributed to this variability.*

A repeated measures proportional odds model was used to evaluate the sequential data presented in Figures 12-20. In Figure 20, the statistical procedure produced a p-value of 0.252 for the difference between the first time teaching an OER class and the second time teaching an OER class. The analysis produced a p-value of 0.806 for the difference between the first time teaching an OER class and the third time teaching an OER class. We have provided this exemplar to illustrate the variability of outcomes based on innovations when the attributes of the innovation are in flux and as user groups become more aware of the strengths and limitations of innovation.

ALEKS™ Summer Math Boot Camps

A significant percentage of students entering higher education in Ohio are not properly prepared to succeed without developmental courses in math, writing or both. In 2010, over 110,000 first time students in Ohio, about 42 percent of the entering population, took a developmental course in their first year of study. Ohio spends approximately $130 million on developmental education. From both the State system's perspective, and from the student's perspective, avoiding costly, non-credit developmental courses is a positive goal to pursue using educational innovations.

ALEKS™ (**A**ssessment and **LE**arning in **K**nowledge **S**paces) is a web-based, artificial intelligence assessment and learning system designed to teach math. The Ohio Board of Regents collaborated with McGraw-Hill to evaluate the effectiveness of ALEKS™ when structured within summer boot camps. Students who enrolled in the summer boot camps offered at five Ohio colleges and universities did so to test out of a requirement to take Developmental Math courses in the Autumn 2011 term.

Learning outcomes among our test sites were promising, although we were again reminded of the variability that can be attributed to local conditions. At four of five test sites, between 28% and 48% of students moved up one level in course preparedness, providing them an option of avoiding at least one course in the developmental course sequence. These changes occurred within eight weeks, validating the benefits of short-term, individually paced math instruction. One of the test sites collected additional data that demonstrated a positive relationship between time using the ALEKS system and subject mastery (See Figure 21). These results suggest that placement test results, in-and-of-themselves, should be re-visited. The goal would be to place motivated students willing to supplement their learning in credit-bearing college courses rather than in developmental courses (Belfield & Crosta, 2012).

Improvements in learning outcomes were greatest with ALEKS™ when an Emporium Model (students attend a computer lab with instructor and peer support) was used with mandatory student attendance. In an entirely at-home, on-line delivery mode, learning outcomes did not improve. The campus that piloted ALEKS™ in this model recommended increased monitoring and student oversight if at-home delivery is the only available option. These findings are consistent with findings reported in the National Center for Academic Transformation *Changing the*

Equation program (Twigg, 2012). This pattern of findings reinforces the outcomes of our Scaffold introduction—local conditions result in variable results.

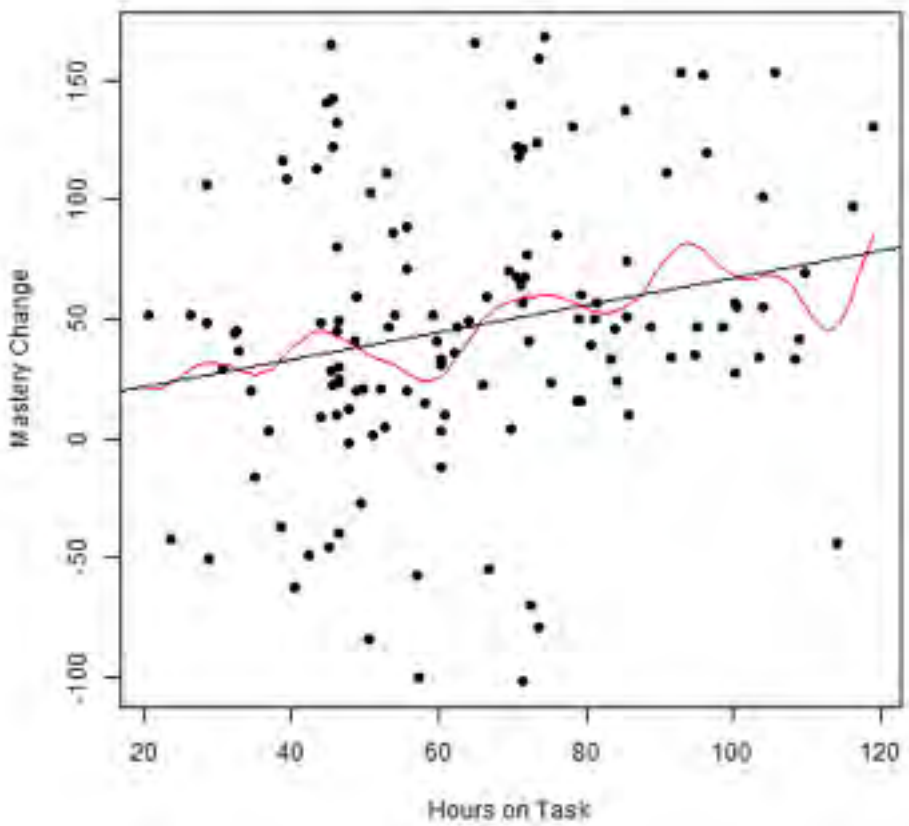


Figure 21. *Increased time on task improved learning outcomes (Mastery) in a learning environment based on the NCAT Emporium Model (p< .01).*

One of the Scaffold campuses also participated in the ALEKS™ study. The students were able to use the OER content to replace the commercial textbook while still benefitting from the self-paced adaptive system. This resulted in significant cost savings because the cost of the supplemental print materials exceeded the per-student licensing costs for ALEKS™.

Triangulated Observations- Accuracy vs. Precision and Quantitative Data

From the beginning of this NGLC project, we have been cautious about aggregating quantitative data as the primary assessment of the innovations we have undertaken. Our principal concern has been that the innovation (a change in learning materials) would have less impact than both the pedagogy of the instructor and the characteristics of the students in the class on learning outcomes. With grades, retention, and deep learning as the dependent variables, our primary concern has been that variability based on the instructor and the class would obscure the effects of using OER. This dynamic was of particular concern because we had a large number of different instructors teaching typically small classes (as few as 4 students and no more than 42 students). These class sizes are not atypical for community

colleges. We believe that collecting data on larger courses offered at a single institution by a small cadre of instructors may have driven the results toward statistical significance, although the effect size of using different learning materials might still be less than could be attributed to the instructor's teaching practices or class characteristics.

With three of our faculty, we were able to compare identical course offerings across time in which one course offering used traditional commercial resources and the other a complement of OER content. Our results again represented variability in outcomes that may be based on instructor or class differences. In two of our three settings, there were no statistically significant differences in learning outcomes when both instructor and term were held constant. In the third example, students exposed to OER demonstrated improved learning outcomes (See Figure 22). In all three of these examples, the data bridged the transformation from quarter to semester systems. Student characteristics may also have been different, representing state-level initiatives to encourage higher enrollments from high-achieving high schools students enrolled in a Post-Secondary Opportunity option.

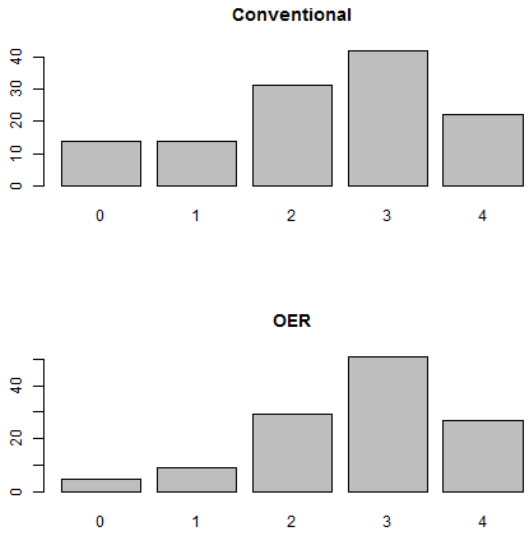


Figure 22. *Three instructors course offerings were matched with the only difference being the use of conventional or OER resources. There were no statistically significant differences in grade distributions for two of the three instructors. The third instructor's classes demonstrated higher grades earned in the OER course (p< .01).*

A traditional experimental approach looks to standardize or stabilize the environment being studied and applies observed results to similar systems. Under these controlled conditions, the experimentalist holds as many dependent variables as possible "invariant" so that the contribution to outcomes of the independent variables can be properly attributed. Even though these controlled conditions are hard to demonstrate in the living laboratory of education, the results can be compelling. Ng (2013) and Means (2013) speak to the benefits of introducing and

tracking educational innovations in MOOCs where time and instructor are held constant and where large class sizes allow experimental effects, regardless of effect size, to be demonstrated at levels of statistical significance. However, in many community colleges, these conditions don't currently attain—it is more the norm to have small classes taught by a diverse group of faculty.

In contrast to a purely experimental approach, Action Science offers a robust description of how organizations learn and ways they interpret and ingest data that result in action (Argyris, Putnam & Smith, 1985). Action Science relies much more on understanding dynamic environments, adapting to them, and adjusting practices to reach specific goals (Schon, 1984). In our case, the stated goals of our project were to reduce costs to students taking college courses and improve their learning outcomes at the same time. We were most interested in driving appropriate transformation in practices of higher education institutions that improved affordability and learning outcomes well beyond these specific courses. An action research paradigm may be preferred at this stage in the innovation cycle.

The data collected from our 73 classes spanning multiple levels of math and statics included initial enrollment, successful completion, grade distribution, and whether students returned to the school in the following term. In most comparisons, the results were "no significant difference" in learning outcomes using this set of dependent variables. If we could claim that the OER-based courses provided the same learning outcomes of those using commercial resources, the project team would have at least partially met its objectives. Such a result would indicate greater value for every academic dollar invested—equal learning at lower cost.

However, our results are more conservatively interpreted as a lack of statistical power or effect size to demonstrate whether learning outcomes were equivalent. Based on the data collected in multiple institutions, with different instructor and class dynamics, and different mixtures of content, we offer this hierarchy of influences on learning outcomes- the faculty member and their conduct of the class is most important, the characteristics of the class itself- aggregated and distributed level of preparation, attendance patterns, and an impossible to define "mix-" some classes want to learn and are easy to teach and others not is of secondary importance. After these two independent variables are considered, the innovation, in this case modular OER, impacts outcomes.

As mentioned before, gathering data across many small courses was difficult- the largest class enrolled 42 students and the smallest four students- produced methodological challenges. This data collection environment increased the influences of instructor and class features. The variance attributed to instructor and class may have overwhelmed any impact, whether positive or negative, of the innovation. Further, the technical features of the delivery systems evolved and both faculty and students developed different use patterns over the course of the project.

This dilemma illustrates the distinction between *accuracy* and *precision* (Argyris, Putnam & Smith, 1985) in applying data-driven outcomes to academic practice. A

larger sample size conducted by a single faculty member at a specific institution, would have allowed a more precise measure the impact of our innovation. This sense of "precision" could drive application in MOOC-like environments, but the resulting relationship between the use of OER and the learning outcomes may not be "accurate" given the variability in the small classes served by different instructors that typify today's Community College.

Summary and Conclusions—An Action Agenda

As we stated in our executive summary, our project has not led to a transformation of the higher education learning environment in Ohio. However, we feel a solid foundation for change has been created and that we've build an advocacy community committed to addressing affordability, learning styles, and effective teaching practices using OER.

To maintain this momentum, we will follow this action agenda:

1. Aggressively share our lessons learned regarding introducing OER into curricula and support new initiatives with planning documents, assessment approaches, and consultations (See Appendix E).
2. Donate our OER resource bases into the forthcoming *iLearnOhio* repository. iLearnOhio is a state-level initiative that will present a catalog of courses that offer college credit to high school students and college preparatory courses. *iLearnOhio* will be unveiled for Fall of 2013.
3. Offer the Scaffold to the Stars repository as a resource for Ohio's eTutoring program. This program provides on-line chat and phone tutoring in a statewide program supported by the Ohio Board of Regents. OER materials can be distributed by on-line tutors to meet multiple learning styles at no-cost to students.
4. Collaborate with extant and future NGLC initiatives (e.g., Kaleidoscope) to more broadly disseminate the outcomes of our work.
5. Support the efforts of one of our partners, Columbus State Community College, as they expand their Scaffold pilot to include all sections of their Math for the Liberal Arts course.
6. Remain active in the accessibility community and share our approaches to providing accessible STEM materials for students with print disabilities. Be prominent in, and promote, the OER and accessibility Partner Community.
7. Maintain the original PHP/mySQL site for the foreseeable future at http://ostts.org under the stewardship of Lakeland Community College. A Blackboard course site containing extensive links to the OSttS resources was built at Lakeland, is available to College Algebra students and faculty, and the Blackboard course archive and Common Course Cartridge archive are freely available.
8. Continue to use and promote the Stitz-Zeager textbook on which the project was originally based. This textbook is now in its fourth edition, remains freely available, and contains many links to OER directly in the Homework Help sections.

In conclusion, and after examining the future of OER from many different perspectives, we would offer the following:

1. OER offers measurable savings for students, low-cost options to serve different learning styles, and greater flexibility for faculty implementing curricula.
2. OER may provide a tool to improve learning outcomes, though the variability in our data and research environment do not offer unqualified support for this assertion.
3. Faculty- their enthusiasm, preparedness, and recognition from peers, administrators and students- will determine whether OER is adopted widely.
4. The textbook is moving from the core toward the periphery of the instructional process; OER must incorporate analytics, learning feedback loops, and multimedia to meet future needs of instructors and students.
5. To promote OER as an innovation requires attention to the classical principles of diffusion; complexity and compatibility are the attributes of OER most in need of attention.
6. The spread of OER, and ultimate transformation in educational practices, requires a community coalesced through unrelenting communication.
7. The contribution of OER to improved learning will be demonstrated in interaction effects, not as a main effect. Matching myriad constellations of OER with different teaching environments and learning requirements is needed and requires further study.
8. The potential for appropriate statistical procedures using large data sets will be helpful in identifying fruitful interactions. However, scale attained by combining data from heterogeneous environments may mask important insights and should continue to be tested in the reflective action of teachers and students.

Bibliography

Acker, S. & Petri, K. (November 14, 2012). *Accessible Open Educational Resources: Ohio's Scaffold to the Stars*. Presented to the Accessing Higher Ground Annual Conference, Westminster, Colorado. Available at: http://go.osu.edu/ahg-2012-ohio-scaffold.

Argyris, C., Putnam, R., & Smith, D. (1985). *Action Science: Concepts, Methods, and Skills for Research and Intervention.* Jossey-Bass available at http://www.actiondesign.com/resources/research/action-science.

Belfield, C. & Crosta, P. (2012). Predicting Success in College: The Importance of Placement Tests and High School Transcripts. Columbia University Teacher's College CCRC Working Paper No. 42.

Christakis, N. & Fowler, J. (2009). *Connected: The Surprising Power of Our Social Networks and How They Shape Our Lives*. New York, NY: Little, Brown & Company.

Dempsey, L. (December 10, 2012). Thirteen Ways of Looking at Libraries, Discovery, and the Catalog: Scale, Workflow, Attention. *Educause Review Online.* Available at http://www.educause.edu/ero/article/thirteen-ways-looking-libraries-discovery-and-catalog-scale-workflow-attention .

Dolence, M. & Norris, D. (1995). *Transforming higher education: A vision for learning in the 21st century*. Ann Arbor, MI: Society for College and University Planning.

Green, C. (2012). The Campus Computing Project. Available at www.campuscomputing.net/ .

Means, B. (February 6, 2013). *Next Generation Learning: What is it and will it work?* Keynote presentation to the ELI Annual Conference, Denver, CO.

Ng, A. (February 13, 2013). *The online revolution: Education for everyone.* Keynote presentation to the eTechOhio Conference. Columbus, OH.

Redden, J. (2011). *Elementary Algebra*. New York: Flat World Knowledge Publishing.

Rogers, E. (1983). *Diffusions of Innovation (3rd. ed.).* New York: Free Press.

Schon, D. (1984). *The Reflective Practitioner: How Professionals Think In Action.* New York: Basic Books.

Twigg, C. (2013). Improving Learning and Reducing Costs: Project Outcomes from Changing the Equation. The National Center for Academic Transformation. Available from the web at:
http://www.thencat.org/Mathematics/CTE/CTE%20Lessons%20Learned.pdf

Appendix A: Scaffold to the Stars Faculty Interview Questions

This interview script was used in 30-minute phone and face-face interviews. Faculty were first asked to recount in their own words their experiences with the project. They next answered a common set of specific questions.

Your "short story"

Before we get into a set of specific questions, please share with me how you talked about this project (reasons for participating/benefits/frustrations, etc.) with a colleague or significant other:

OK, here are the specific questions:

Cost:

- What were the rough costs of your course materials before and after this project?
- Were textbook costs really a factor for your students or did financial aid take care of this concern in most cases?

Quality:

- How would you compare the instructional quality of the OER materials compared to the previously used materials in the course?

Implementation:

- Did you change the way you introduced the OER materials as you gained experience over multiple classes and terms?; what strategies did you find that effectively promoted use?
- What were the top three hurdles in adopting OER?
- How could you have been better supported?
- What role, if any, did these stakeholders play in your thinking about and adoption of OER? Publishers? Administrators? Fellow colleagues? Students? The Bookstore?
- How important was consultation with a librarian in developing your OER class materials?
- Do you intend to continue using OER now that the project is done?

Students:

- Did students with different characteristics (abilities/capacity/time constraints/age/gender) use the OER resources in different ways?
- Why do students appear to have more difficulty learning math compared to other subjects?
- How would you measure "deep learning" of mathematical concepts?
- Did you work with any students who demonstrated print disabilities?

Your Turn

- If you could start over with this project, what would you have done differently? What should the project have done differently?
- What important questions did I fail to ask?

Thank you!

Appendix B: Ohio Scaffold to the Stars Student Survey Instrument
Autumn 2011 to Autumn 2012

This survey was formatted and delivered through Survey Monkey at the end of each academic term.

This course used learning materials available in print and also as digital (electronic) files. Please tell us about your experiences with these materials. The survey has 20 questions and will take about 15 minutes to answer. Thanks very much!

1. Your instructor assigned you an ID code to respond to this questionnaire. Please enter it here: _____

2. How often did you access the learning materials (both print and digital)?

Every day
Regularly - Several times a week
Occasionally – A few times a month
Only when studying for a test
Only a couple of times
Never

3. In a typical week, how many resources did you use:

one, the main textbook for the class
two, the textbook and at least one other resource provided by my instructor
three resources per week
four resources or more per week
none, I attended class but never used the book or resources out of class

4. The week before a test, I

spent additional study time reviewing the book
used two or more learning resources, including problem sets
studied the same as I did every other week

5. The most useful resource that helped me learn was:

the assigned textbook
other readings and websites made available by my instructor
problem sets that let me practice my understanding of the material
YouTube videos that reviewed concepts covered in class

6. I found the Khan Academy videos:

excellent
good
average
not very helpful
I didn't watch any Khan Academy videos

7. When I think of other college students, I can use a computer (select one):

much better than most other college students
better than most other college students
as well as most other college students
not as well as most other college students
most other college students can use a computer better than I can

8. I accessed my learning materials using (check all that apply):

my own laptop
my own desktop
a workstation I share with others at the library or my home
my phone
my tablet (iPad or Android-based tablet)
my netbook
only as print materials

9. I plan to purchase an iPad or Android-based tablet in the next six months

___yes ___no

10. Please rate your level of agreement with the statements about your textbook and online learning materials based on your experiences in this class.

	Strongly Agree	Agree	Disagree	Strongly Disagree	N/A
Online learning materials provide more flexibility than printed, hard copy textbooks.					
Online learning materials provide the same level of quality as printed, hard copy textbooks.					
Online learning materials contain more up-to-date material than printed, hard copy textbooks.					
It was easy to use the online learning materials.					
The online learning materials increased my understanding of course content.					
The online learning materials helped me get a better grade in this course.					

11. Compared to other textbooks I have used for similar courses, I felt the textbook used for this course was:

More The Same Less

Engaging
Detailed
Thorough
Understandable

12. Compared to digital learning resources and websites I have used for similar courses, I felt these digital learning materials were:

	More	The Same	Less
Engaging			
Detailed			
Thorough			
Understandable			

13. Did you purchase a print copy of the textbook?

Yes
No

14. Regarding the materials available in the Ohio Scaffold to the Stars online library, how often did you print the materials instead of just using them on the Internet?

Always
At least half the time
Seldom, less than half of the time
Never

15. I found the Ohio Scaffold to the Stars database website

very easy to use
easy to use
somewhat difficult to use
very difficult to use
I didn't use the Ohio Scaffold to the Stars database website

16. I prefer digital learning materials to paper textbooks.

Strongly Agree Agree Disagree Strongly Disagree N/A

17. I thought the cost of the learning materials (textbooks) used in this course was:

more expensive than other courses I've taken
the same expense as other courses I've taken
less expensive than other courses I've taken

18. If there is one thing that I liked best about using open source (free) learning materials, it was:

19. If there is one thing that I liked least about using open source (free) learning materials, it was:

20. Please provide any other comments about the course and its learning materials. Thank You!

Appendix C:
Representative set of student comments regarding OER-based content used in an early math course

Students were asked twenty questions regarding their perceptions of the Scaffold modular course content. The final three questions were open-ended. These responses were gathered in a Fall 2012 lower-level, credit-bearing math course.

If there is one thing that I liked best about using OER ...	*If there is one thing that I liked least about using OER...*	*Please provide any other comments about the course and OER...*
		Please, please, please continue to do this! Many students suffer in math classes because they can't afford the book. They rely only on the lecture part of the class with the hope they will get it right away. But sometimes the lecture is not enough, and they need the book. These free online sources make this information accessible to all, allowing those students with less funding more likely to succeed in the class. I loved being able to save the $160 it would have cost to purchase the book for the course I was taking, and instead spend it on books I needed for my other courses. This is a great program and should be continued for all math courses!
I loved having access to a free textbook, where I could pick and choose which materials I could print. I didn't have to lug around a bulky, expensive textbook, and instead, if further study was needed in certain chapters, I was able to print them and have them to study from. I loved that I could also mark up the printed copies, without worry of devaluing the textbook. In the case of an actual textbook, you run the risk of devaluing the sell-back cost when highlighting or making notes, causing less efficient study methods. I liked that I didn't run that risk with the free online materials.	I learn better from materials that I can highlight and make notes in. I prefer to have printed materials, but I loved the accessibility of the online sources! I was able to print out what chapters I needed for free, and was able to study from those. The disadvantage of them being online corrects itself, so there is no real disadvantage!	
I was able to print the book online for free and the instructional videos.		I appreciate the free book!

It always makes me angry when a professor tells the class that they will need to purchase a text book worth hundreds of dollars, and than we barely end up using it. Although I did use the online text book a good amount, it was very nice not having to spend all of the money on it.	I never had an issue with it, but maybe if I were in a situation where I needed it and could not access a computer, it could be a problem.	I really enjoyed this course. It was probably one of my favorite math courses I have taken. This is math that I could actually want to use in the real world. The professor was excellent and did a great job at teaching the subject. It all clicked with me right away. The free text book was a plus as well!
The fact that it was free and you can look it up no matter where you are and don't have to worry about remembering a book. Plus the information was easy and able to be printed off.	n/a	The teacher was very engaging and descriptive. He provided many examples and offered many examples in class and online to make sure we were successful, the rest was up to us to study. However going to class was far more helpful than any online tools.
VIDEOS AND FREE BOOKS	I UNDERSTAND	N
I liked the fact that it was free. I did not have to worry about hauling around a large book. Not to mention it was very expensive.	There were no cons to using an open source.	
It’s Free. College cost enough!!!!	none.	We need more like this.
I like the open source concept in general.	It isn't practical for maximizing study time to have to be near an internet connection.	n/a

The professor cut most of the material that wasn't being used and we just used what we needed and this saves me from carrying a lot of material. This also helps because I know exactly what to study and the videos provide extra help if I have a question or don't understand the material.	It was free and saved me a whole lot of money and I didn't have to waste time carrying that heavy text book. Loved this set up because it was detailed, easy, & made math fun for me.	Before I came to this class I did not like math because it is difficult for me & I do poorly on test even if I understand the material. My instructor & the material that was provided for me made it easier for me to learn the material, but I still had trouble with the test. I really thought the videos were very helpful when I came home because I would sometimes forget the formula, so this was very helpful.
Making a college education more affordable by reducing the need for printing a hard copy. Textbooks are far too expensive, and purchasing them is a major stumbling block for people. There is tremendous value in open source learning materials.		
An easier understanding of the course and its materials and saving money on a resource I would only use for a short period of time and then never again.	Nothing	An excellent resource that I hope will continue to grow
The video's were a huge help		
free and/or affordable	none	
I liked the variety of learning tools		

		It would be a great advantage to future students to continue with this course of study! The book is very detailed and the videos are extremely helpful! The free book is also a great attribute for students taking this required course! The instructor was very instrumental in my ability to comprehend the material presented in the book. Having access to the videos prior to class gave me an edge when the professor further explained the material in class! A heartfelt thank you to all parties involved in choosing this course material!
The material was easier to comprehend and I loved the costs savings!	There was not anything that I did not like. The course material was very detailed!	

Appendix D: 3-D Printing- A link to an advanced manufacturing economy

Under the supervision of Professor Russ Marcks, students at Sinclair Community College created 3-D maps of Ohio that represented enrollment at Ohio colleges and Universities. Students at Belmont Community College, Edison Community College, Lakeland Community College and Southern State Community College also integrated the MakerBot 3-D printer into their Statics curriculum. These technology-based skills are valued by a number of Ohio businesses gearing up to enter the "new manufacturing economy," and we feel that providing concrete activities that utilize math is motivating for many students. When asked to describe their preferred learning style, 51% preferred "active, hands-on learning," 24 % preferred "reading about it," and 25% preferred "watching demonstrations on video." OER supports multiple learning styles without additional costs.

This map of Ohio represents colleges and universities and their enrollment patterns around the state. The map was created using the 3-D printers provided by the Scaffold Project.

Appendix E. Scaffold to the Stars Dissemination events

Ohio Scaffold to the Stars Dissemination Activities

This is a selected list of Ohio's Scaffold to the Stars dissemination activities

Polanka, S., Schiller, S. & Acker, S. (April 12, 2013). *Digital Textbooks: Alternatives, Initiatives and the Role of the Academic Library.* To be presented to the Association of College Research Libraries Annual Conference. Indianapolis, IN.

Millichap, N., Acker, S., Thanos, K., & McElroy, C. (March 12, 2013). *Sharing Building Blocks: Lessons Learned from the NGLC Collaboration Experience.* To be presented to the League for Innovations Annual Conference. Dallas, TX.

Acker, S., McCoy, D., & Ginn, C. (February 13, 2013). *eTextbooks in Ohio: Third Year Annual Report.* Presented to the eTechOhio Annual Conference. Columbus, OH.

Acker, S. (February 5, 2013). *Diffusing digital textbooks: Foundational State strategies, results, and stage 2 initiatives.* Presented to the Leadership Track at the Educause Learning Initiative Annual Conference. Denver, CO.

Acker, S. & Petri, K. (November 14, 2012). *Accessible Open Educational Resources: Ohio's Scaffold to the Stars.* Presented to the Annual Accessing Higher Ground Conference. Denver, CO.

Acker, S. (November 8, 2012). *Ohio's Scaffold to the Stars: Key Diffusion Strategies*. Podcast recorded at the Annual Educause National Conference. Denver, CO.

Polanka, S., Acker, S., Brown, B., & Metz-Wiseman, M. (October 17, 2012). *Creating a Walled Garden: Digital Textbooks in Higher Education.* Presented in the National School Library Journal Webinar. Columbus, OH (online).

McCoy, D., Acker, S., & Massis, B. (September 4, 2012). *The Ohio Textbook Affordability Summit (Survery and Executive Summary).*

Magill, J., Acker, S. & Nardacci, C. (July 9, 2012). *Digital textbooks: Ohio Opportunities.* Presented to the OhioLINK Math and Chemistry Collections Meeting. Columbus, OH.

Acker, S. (June 29, 2012). *Digital textbooks: Ohio's goings-on are ongoing.* Presented to the University of Illinois UnConference on Digital Textbooks. Champaign-Urbana, IL.

McCoy, D., Magill, J. & Acker, S. (May 10, 2012). *Textbook cost savings and student success.* Presented to the Chief Academic Officers Council. Columbus, OH.

Acker, S. & Magill, J. (April 27, 2012). *Open Textbooks in Ohio: K-12, Higher Ed and the*

Library. Presented to the Academic Library Association of Ohio. Columbus, OH.

Acker, S., Magill, J., & Macconnell, I. (April 24, 2012). *Open Educational Resources: Accessibility's Achilles Heel.* Presented to the Annual Multiple Perspectives Conference. Columbus, OH.

Acker, S. (April 16, 2012). *Research parameters of open educational research.* Presented to The Cambridge Summit. Cambridge, MA.

Acker, S., Getis, V. & Magill, J. (April 12, 2012). *Digital Textbooks: Social And Economic Factors Of Diffusion*. Presented to the Ohio State University Innovations Conference. Columbus, OH.

Acker, S. (March 8, 2012). *Strengthening Ohio's STEM ladder*. Presented to the Business Alliance for Higher Education and the Economy Executive Board.

Acker, S. (February 8, 2012). *The Ohio Digital Bookshelf: State-level strategies.* Presented to the 2012 Florida Distance Learning Consortium Conference**.** Orlando, FL.

Acker, S., Magill, J. & O'Beay, A. (February 4, 2012). *Ohio Scaffold to the Stars (OSTTS): A Building Agenda.* Presented to the Annual Educause Learning Initiative Conference. Austin, TX.

Acker, S. (November, 2011). *Digital Textbooks: A state level perspective on affordability and improved learning outcomes.* The American Library Association: Library Technology Reports.

Zell, D., Acker, S., Budzick, D. & Shelstadt, J. (November 9, 2011). *Open Textbooks: Research Findings on Affordability, Acceptance, Accessibility and Learning Outcomes.* Presented to the Sloan-C Conference. Orlando, FL.

Millichap, N., Acker, S. & Bergeron, C. (October 10, 2011). *The Next Generation Learning Challenges: Implementation Reports from Wave I Projects.* Presented to the Transforming Higher Education Conference. West Lafayette, IN.