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BRIEF SURVEY OF ANALYTICS IN K-12 AND HIGHER EDUCATION

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Abstract

Use of computers in education is now ubiquitous. Students have access to course media through a variety of devices including PCs, tablets, and smart phones. The data generated by online learning platforms have the potential to change the way we teach and learn. In this brief survey paper, we explore the role of analytics in teaching and learning. In particular, how learning analytics can lead to educational process innovation. We will explore history, current state, tools, privacy issues, case studies, and future potential for analytics-based education.

KEY WORDS: analytics, K-12, higher education, data driven, analytics driven

1. INTRODUCTION

In this inaugural edition of the *International Journal on Innovations in Online Education*, we explore the role of analytics in teaching and learning. In particular, how learning analytics can lead to educational process innovation. Analytics is the discovery and communication of meaningful patterns in data (Wikipedia, 2001). The main goal of using analytics is to go beyond descriptive statistics to provide the best prediction of what may happen in the future. The end result is to streamline decision making and produce new insights that lead to better actions. As more and more technology is integrated into today's instruction from K-12 to higher education to continuing education, there is an unprecedented opportunity to use analytics to make learning more effective and efficient (Campbell and Oblinger, 2007). This paper explores some current efforts in analytics-driven education and its potential as a revolutionary force to change the way we teach and learn. We will discuss case studies on how analytics were used in multiple disciplines and will highlight some of their impact on teaching and learning. As more and more data are collected, there is the opportunity to analyze and extract meaning from this data. The advances in machine learning and data sciences will also contribute to analyzing millions of data records fast and deriving actionable intelligence. In the next few sections, we will explore history, current state, tools, privacy issues, case studies, and future potential for analytics-based education.

2. HISTORY

Predictive analytics has its origin in the 1940s, when governments first started using the computational models with early versions of modern computers. Today, we have the enormous capability to collect and process large amounts of data in seconds to provide more real-time analytics. For years, the use of analytics has enabled businesses to make smarter decisions and to run their organizations more effectively (Business Analytics, 2001). Predictive analytics is the process of deriving what might happen in the future based on historical patterns of data. It uses a variety of techniques such as data modeling, machine learning, and statistical techniques to make these predictions. Although most businesses have always used data to drive their business decisions, education has been lagging in these areas. Historically, resource constraints have been an obstacle for educational institutions and faculty who would have preferred to use this data in a meaningful way to extract actionable intelligence. Also, most early learning management systems and other educational platforms did not have the open data exchange methodologies that are more readily available today in most platforms.

Use of technology in education is not new. It started with the introduction of course management systems (CMS) such as Blackboard (Blackboard, 1998) and eCollege (eCollege, 1996) in the late 1990s and early 2000s. These platforms allowed instructors to organize their courses and provide access to calendars, discussion forums, content, and assessments. The grade books in these early systems gradually replaced the paper versions of grading systems. These platforms allowed grade books to be exported in Excel format to be analyzed further. More widely used educational platforms such as Blackboard (Blackboard, 1998) contained other statistics such as quiz access times and success rates in specific questions, among many other things. Since then, the Blackboard system has improved tremendously by providing more detailed data about student and course activities. In 2007, Purdue University launched Course Signals (Course Signals, 2009, Arnold, 2010) one of the earliest uses of comprehensive learning analytics. The project integrates data from multiple sources including student information systems, course management systems, and course grade books to generate a list of at-risk students targeted for intervention. In 2008 (Knewton, 2008), an adaptive learning technologies company that provides personalized learning to K-12, was formed. The company collects data about student learning and provides customized lesson plans to individual students. Edmodo (Edmodo, 2008) is another educational technology company formed in 2008, offering communication, collaboration, and coaching tools to K-12 schools and teachers. Edmodo is a popular platform among teachers who use it to organize their courses using a familiar social media metaphor. Classroom Salon (Classroom Salon, 2008) was formed in 2011 as a learning content management system (LCMS) as a result of years of research at Carnegie Mellon University (CMU). An LCMS integrates administrative functionalities such as creating and managing learning communities ("salons"), authoring content, scheduling activities, and closely tracking online learning activities and providing detailed analytics including summarized user and document activity reports, document access trends, and export capabilities for each interaction record. These LCMS systems allow greater flexibility in customizing courses, introducing new instructional designs, and modifying instructions based on system analytics. Course Smart (Course Smart, 2007), a digital textbook provider, formed an alliance with five textbook publishers to offer the analytics package called Course Smart Analytics that tracks the student engagement with course textbooks and provides reports to professors who can then assess student effort. There are many other initiatives aimed at using learning analytics in educational settings and many are listed in the Horizon Report by New Media Consortium (Johnson, et al, 2013).

Historically, teachers have always used grade books, course objectives, and individual student observations to make informed decisions. In smaller classes, it was easier to detect students who are at the risk of dropping out and then take measures to fix the problem. But this is difficult in higher education where class sizes have grown considerably larger especially in demanding areas such as computer science and engineering. In these large enrollment classes, other techniques were necessary to analyze large amounts of student data. Data mining in higher education is not new and many have used supervised and unsupervised learning algorithms to predict the potential for student success (Luan, 2004). The accountability, demands for information, and the role of information technology in colleges and universities have been discussed extensively in the literature (Hawkins, 2008). National agendas for action analytics have been developed (Norris et al., 2009), but the use of analytics by individual instructors to improve everyday teaching remains low. Now there is a greater opportunity to discuss, develop, and implement methods and tools that can provide us deep insights into teaching and learning. In recent years, tools and methods have been developed to help instructors use analytics in their teaching. Some platforms also provide student dashboards (Classroom Salon, 2008) that can inform the student when they are at the risk of failing or falling behind. Use of analytics in education is now gaining ground. Some educators are proposing to adopt a common language to discuss analytics in education (van Barneveld et al., 2012). Some have examined the conditions for engagement in online learning environments and the role of the instructor (Ma et al., 2015). There is enough evidence to show that the proper use of data leads to smarter teaching and better learning outcomes (Dawson et al., 2008). Learning analytics is the third wave in education that began with the advent of course management systems (Brown, 2011).

3. CURRENT STATE

Use of computers in education is now ubiquitous. Students have access to course media through a variety of devices including PCs, tablets, and smart phones. The data generated by these devices can be broadcast to an entire class or individual students as activity streams. An activity stream is a continuous list of time-stamped system activities (such as document uploads, student comments and discussions, notifications of important events) that informs students of the current state of the course. The use of social networks such as Facebook and Twitter has promoted the use of activity streams to inform latest news updates, status changes, and shared stories to its users. This concept of social media type activity streams can be expanded to education to include the notification of aggregated activities that can be highly beneficial to the student. The power of these activity streams lies in their ability to record change as it occurs. In the context of education, they have the potential to increase student motivation (Wankel and Blessinger, 2012) as personalized activity streams are continuously broadcasted to students.

The role of data in education is not simply to transfer pre-digital-era content (textbooks, surveys, and questionnaires) to the digital era, but also introducing more qualitatively rich data to make the analysis about the learner status more accurate. The new data are ubiquitous, persistent, and connected, making them different from the data we have been able to collect in the past. Unlike in the past, now it is easy to generate data by designing learning activities to measure student understanding of concepts. For example, highlighted passages and student comments can inform instructors on the collective or individual understanding of a particular concept.

We define data-driven education as the ability to use real-time data to drive instructions. For example, if the instructor knows where students are having trouble, then the lecture can be customized to serve the students better. The current popularity of flipped learning models provides an excellent opportunity to collect learning data before the instructions occur. Flipped learning requires students to engage with content before face-to-face meeting times. This engagement data can then be used to customize in-class instructions.

One difficulty in higher education is that the amount of data available to instructors to make decisions is fairly small. This is mainly due to limited knowledge that higher education instructors have about the prior knowledge of the students they are teaching. Making decisions from “small data” is a new area of study that has gotten attention in recent times (Lee et al., 2015). Often, instructors only know that a student has completed a prerequisite course or two, but do not have enough data to assess the depth of understanding of prior subject matter. Therefore, small data methods require more continuous data streams to make informed analytical decisions. Data is only a representation or symbol of what happens in the world. In most contexts, the goal of data collection and analysis is to provide insight and the basis for informed decisions. The process of setting up, collecting data, converting data to information, and using actionable intelligence to make informed decisions is a critical step in implementing a data-driven learning strategy. As shown below, the educational environment must be established to collect data, data need to be processed to obtain information, and information needs to be analyzed to generate actionable intelligence (Fig. 1).

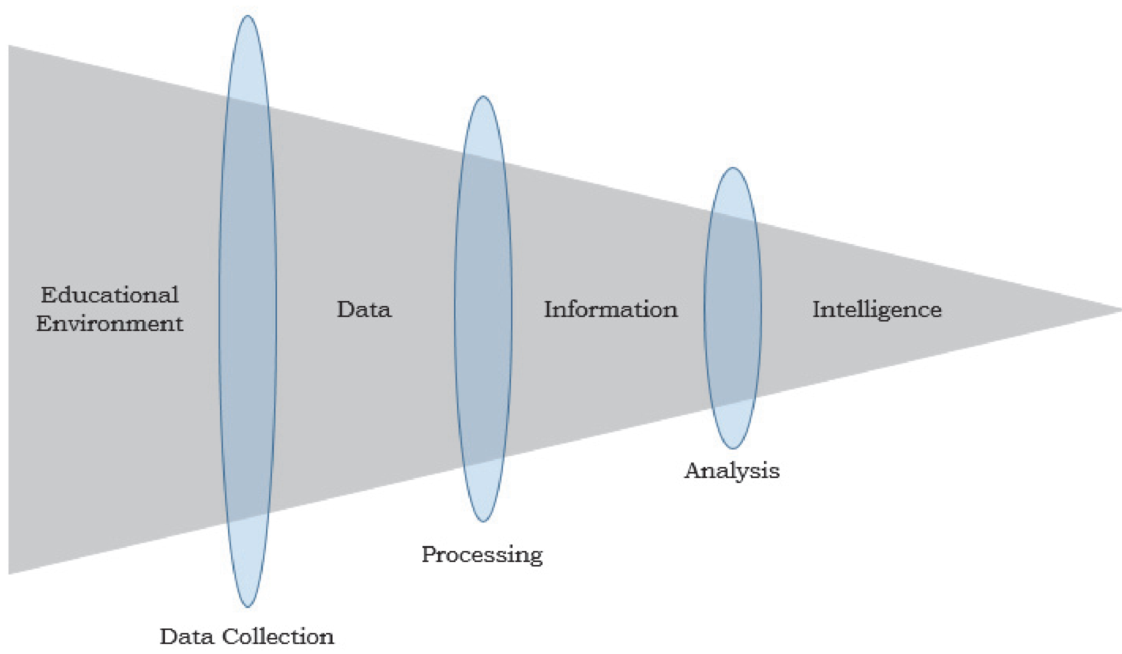

FIG. 1: From Data to Intelligence

The promise of learning analytics is the opportunity to reduce cost and obtain better learning outcomes by smartly combining human and technology resources. More and more funding agencies are recognizing the need to scale education using learning analytics. Google recently provided funding (Google, 2015) to CMU to study how to scale computer science education using learning analytics. CMU will use Classroom Salon (CS) as the learning analytics platform for the proposed study.

The use of analytics in improving business processes is not new (Business Analytics , 2001). Businesses have been using analytics to find better ways to serve their customers and increase sales for many years. More and more businesses are employing data scientists to go through vast collections of business data to extract market and customer intelligence. Of particular interest are the hidden patterns that can be discovered as a result of utilizing novel algorithms. These data provide valuable insight into what customers want and what they would pay for a product. Companies increasingly need to generate new sales and continue existing sales. Companies are now using this vast collection of data to do just that. The "business" of education is no different. Education must be efficiently delivered and outcomes must be validated. As more and more educational services move to cloud architectures (Cloud Computing, 2014), the opportunity to store, share, analyze, and act on data also increases at a global scale. More and more businesses are tracking their customer clicks to know how much time they spend on a site and how to improve a specific page or product offering. This is no different for education. If educators know what resources students are accessing, how they are reading documents or watching videos, where they find important or confusing information, it is possible to act on the data to provide better classroom instructions (Gunawardena and Kaplan, 2013). For those who are using YouTube videos as part of their instructional strategy, Google provides a host of data including total access times, average access times, and geographical data to give a sense of how important a particular video is. For example, if students are returning to a particular video many times, that can indicate importance or difficulty of the video content and instructors can devise strategies to address the student needs better. We also need to underline the potential negative effect of analytics in education, as collection of vast amounts of data can raise privacy concerns. The privacy issue is even more relevant in K-12 education where collecting any kind of student behavior data can be controversial. Another risk of having "too much" data is that of educators counting solely on analytics to make decisions. Therefore, it is important to find ways to balance the need to use analytics to improve education while minimizing the risk of that data being used for unintended tasks or misinterpretation. This is the challenge and opportunity that we have in front of us.

In developing this paper, we contacted a number of instructors who use educational analytics to change the way they teach and assess their students. These instructors used many different platforms to gather the data. The tools varied from legacy course management systems such as Blackboard and Moodle, to more recent learning management systems like Edmodo and Knewton. We also included "deep analytics" based platforms like CS, an analytics-driven social interpretation tool developed at Carnegie Mellon University. Deep analytics can be defined as the process of extracting intelligence from large and multisource data sets that may be structured, semistructured, or unstructured. Classroom Salon can aggregate large amounts of data from multiple sources, including student access of documents and videos, highlighted text and video data, and self-organized networking within the system to produce actionable analytics reports. The goal of CS is to increase students' direct engagement with content and using these data to extract hidden information such as student sentiment and use of language to demonstrate understanding, excitement, or confusion (Kaufer, 1998). For completeness sake, we also mention intelligent tutoring systems based platforms like Open Learning Initiative (OLI) (Open Learning Initiative, 2001). OLI platforms have played an important role in managing student learning using a solid research base in learning sciences. OLI systems heavily use analytics to provide customized learning paths to individual students and have played an important role in education for over 20 years. OLI based courses however are not easily customizable and hence not easily adaptable. For the purpose of this paper, we only included a few platforms where individual instructors build, deploy, and assess student outcomes. However, we note that there are many other platforms with built in courses and analytics that can help drive the teaching and learning strategy. We hope to address those platforms in future issues. The actionable data generated in the quoted studies were quite significant in teaching and assessment of student learning and were used frequently to improve class instruction. For future editions of this journal, we invite educators and institutions to submit papers where use of analytics lead to better class instructions and learning outcomes.

4. TOOLS

Almost every academic course is now supported by one or more electronic platforms. The majority of the instructors we surveyed use course management systems such as Blackboard, Moodle, Canvas, and Sakai, among many others. Our surveys indicated that most instructors use these tools simply as content, quizzing, and grade book repositories. Instructors also use these tools more as a convenient way to distribute course material, gather student submissions, make announcements, answer student questions, conduct tests/quizzes, and record student grades. Platforms such as Blackboard (1998) are also integrated with a number of third party applications like turnitin.com, a plagiarism management tool, and Q&A tools like Piazza (2011). Almost all of the course management systems we considered had some analytics, although few instructors used these data to assess student engagement in order to improve teaching. Moodle, for example, provided data on how much time a student spent on the site, or how many students accessed a particular assignment, or how many assessments students completed. A basic grade book is part of all these sites and instructors can often see if a student has failed to submit an assignment or has not attended the class. Most educators do not pay much attention to internal data such as time on the site or if a particular student accessed an assignment. Instructors often do not have enough resources or knowledge to use data such as time on site to better their teaching. But most instructors used observations such as lack of engagement, timely completion of assignments, and low exam scores as indications for increased risk of course failure or dropout. The newer educational platforms such as Knewton (2008) and Edmodo (2008) provided more comprehensive analytics and better dashboards. Knewton for example, used data modeling to drive student learning paths. Edmodo provided more social features such as messaging and networking. Edmodo is also supported by a number of applications that can be integrated into instructions. The deep analytics platforms like CS (Classroom Salon, 2008) provided very specific data on how students view and interact with specific content (to the individual word or video frame). The contentcentric aspect of Classroom Salon (CS) provided an alternate way to design activities and collect more fine-grained analytics. In CS, interactive learning activities can be built into the context of media (highlighted text or video prompt) to engage students directly with content. The "hotspots" generated by student annotations can be interpreted and used for teaching and learning.

5. PRIVACY ISSUES

Perhaps the biggest barrier to data-driven education is privacy. It is a difficult balancing act on deciding what data to collect, what data to display, what data to analyze, and what data to act on. The Gates Foundation (2000) has long supported initiatives based on data-driven learning in K-12, but has been challenged many times due to privacy issues at local, regional, and national levels. Educational institutions often struggle with these questions on balancing privacy versus using data to support teaching and learning. If a higher education faculty member wants to collect data, analyze, publish, and present in a conference, they often require the permission of the institutional review board (IRB). IRBs often grant this permission to research projects that are low in risk. Fortunately, educational data analytics can be categorized as low-risk experimentation as long as individual privacy is maintained. Platforms such as CS and others allow students to comment and reply anonymously to other users, while disclosing student identities only to instructors. One other way to overcome the privacy issue is to assign special codes to students. The true identities of students are stored in a centralized secure database with access to a specific student only provided when it is in the best interest of the student as determined by a person of authority. As long as institutions and researchers can satisfactorily guarantee that data will remain private and only accessible by authorized people, the opportunity to collect data and use it for actionable and predictive analytics will remain strong. Privacy concerns alone should not be a barrier to analytics-driven education. Processes and policies must be developed at all levels to balance the need for privacy versus the enormous potential of data. Systems can also provide options for "opting-out" that can allow individuals to decide when to allow institutions to collect their educational data. We invite potential authors to submit papers on data privacy for future editions of this journal.

6. CASE STUDIES

In this section, we discuss some case studies involving tools such as Edmodo, Knewton, and CS. These case studies may represent only a handful of analytics-based activities happening throughout the United States and elsewhere. Based on the preliminary research we did, the use of analytics in education remains low among faculty. Most analytics-based educational initiatives are carefully designed local, regional, or national studies and have not scaled to institutions outside of the research community. We found little evidence that individual instructors use analytics for day-to-day decisions on what to teach and how to teach. However, we saw increasing evidence of the use of real-time analytics to better education in cases like Chemistry Education (Blecking, 2014). In the following section, we discuss some case studies involving Edmodo (2008), Knewton (2008), and CS (Classroom Salon, 2008).

6.1 EDMODO

Edmodo is a popular social learning network in K-12 space. According to website, the site has over 15 million users. The site is easy to use, encourages Facebook-like communication among students, and provides tools for teachers to monitor activities. The major analytics functionality is only available to administrators. The administrator can monitor how many teachers and students are logging into Edmodo on a daily basis. At a super administrator level, the analytics can show school activities, school accounts, and an overall district summary. It can also show schools in a stack-ranked mode with the most active school on top. Clicking on each of the schools can show a stack-ranked list of most active teachers, students, and groups. Clicking on either teacher or student names will show you a list of all their posts, as shown in Fig. 2.

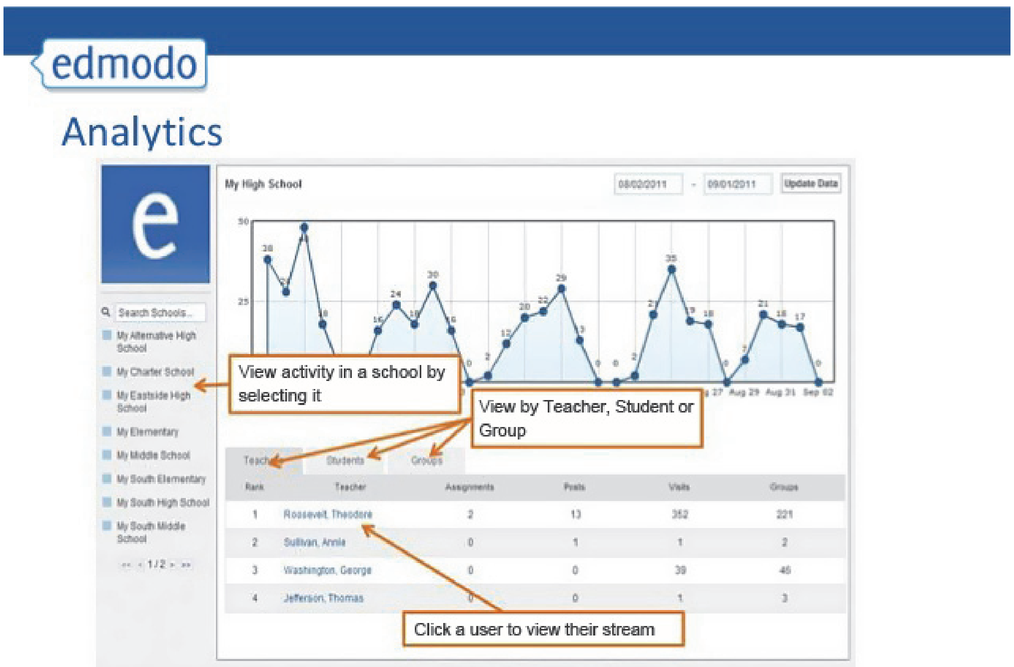

FIG. 2: Edmodo District Dashboard

We list two case studies that Edmodo provided to us based on our requests for information.

6.1.1 Edmodo Case Study 1: District Spotlight Chula Vista Elementary School District, California

This study involved Edmodo helping to improve learning and engagement for English language learners (ELLs). Although the Chula Vista Elementary School District (CVESD) has been steadily improving academic proficiency levels over the past 10 years, the academic achievement gap between ELLs and others was evident. CVESD sought new ways to deepen student engagement and expand learning beyond the walls of the classroom prompted by concerns that this gap could increase as

California transitions to Common Core State Standards. CVESD wanted to find a solution that would be easy to use for teachers and students alike. CVESD noted that Edmodo was used successfully in another district's Gifted and Talented Education (GATE) Program for those at risk of being left behind. The district selected a cohort of 20 teachers to enroll in "Edmodo in Action," a six-week online professional development program designed to help teachers integrate Edmodo into their daily practice and meet their instructional goals. By focusing on the end and not the means, the program also equipped them to serve as mentor-teachers to their peers, helping to scale training across the district. The program served 29,000 students, 1500 teachers, and 47 schools. Administrators and teachers used data visualization on CVESD network activities and on the Edmodo teacher connection. This resulted in a well-supported, yet grassroots adoption of Edmodo district wide. Teachers, students, and parents quickly adopted the platform and within 12 months 100% of teachers and 75% of students in the district were registered users. Using Edmodo as their social learning platform, CVESD was able to focus on closing the learning gap with ELLs by providing personalized support using data analytics, as ELL students often require individual attention from a teacher to increase the chance of success. The ELL students who did not want to participate verbally in class for fear of their accent or mispronunciation were able to compose their thoughts in writing. Teachers placed students in small groups so they could learn comfortably alongside similar peers. Because Edmodo is available online and via mobile devices, it facilitates anytime, anywhere learning and access to classwork and as a result many data points were generated to support administrators to assure program success. The Edmodo analytics showed that students were active throughout the week, including Saturday and Sunday. Edmodo analytics and online tools also gave the ability for teachers to keep parents involved. In addition to adopting Edmodo in the classroom, CVESD is also using Edmodo to increase district-wide collaboration by creating virtual professional learning networks. Edmodo learning analytics played a crucial role in the success of this study.

6.1.2 Edmodo Case Study 2: District Spotlight Chesterfield County Public Schools, Virginia

Edmodo helped the Chesterfield County Public Schools (CCPS) district support the "Design for Excellence 2020" strategic plan and scale blended learning. In early 2012, Chesterfield County Public Schools (CCPS) identified a need for a teaching and learning platform that could meet a variety of communication and instructional needs. The system must also integrate with existing platforms like Google Docs and it must be deployed in less than a year. CCPS found that teachers favored Edmodo because of peer recommendations and for its familiar and intuitive user interface, seamless communication between teachers and students, easy-to-build formative assessments, engaging educational apps, and accessibility from any device. The study involved 58,800 students, 4200 teachers, and 42 schools. Edmodo was adopted for increased student engagement as student experience with similar platforms meant that students quickly and easily embraced Edmodo. To start the process, CCPS established an Edmodo subdomain, which gave district administrators the ability to manage and support site usage by using Edmodo analytics, as well as foster district-wide communication and collaboration. They then trained 4200 teachers over the course of three days during summer break, in preparation for the 2012–2013 school year. With Edmodo's free platform, CCPS now has a successfully executed blended learning strategy with increased student engagement and near-district-wide adoption. Building on this momentum, CCPS has scaled its blended learning efforts in the 2013–2014 school year through an expanded digital ecosystem in which Edmodo serves as the hub. The use of Edmodo data was instrumental to the success of this effort.

6.2 KNEWTON

The Knewton (2008) platform is a flexible, scalable system for delivering adaptive learning experiences and predictive analytics across arbitrary collections of content in different learning environments. Knewton processes student interactions within learning applications to personalize digital coursework and effectively reinforce class lessons. Knewton supports the learning process with three core services: recommendations for students, analytics for teachers and students, and content insights for application and content creators. Although adaptive tutoring systems are themselves not new, a traditional problem they face is that they are often bound to a single grouping of content. Even where they are not, adapting the tutoring system to a new collection of content is an expensive and time-consuming process. The Knewton platform builds on decades of research in adaptive tutoring systems, psychometrics, and cognitive learning theory, but also contains several key innovations that make it possible to quickly and efficiently integrate with new collections of content. This enables the benefits of adaptive tutoring to reach far more students across more domains more quickly. One of these innovations is the Knewton knowledge graph and its associated graphing ontology, which provides flexible and expressive ways to describe relationships between content. These expressive relationships are drawn from pedagogical reasoning and are intended to map easily to human intuition, which allows Knewton and its partners to quickly graph new content into an information-rich, machine-readable state. The resulting content graph is then used in conjunction with up-to-the-minute descriptions of students' abilities determined by a real-time psychometrics engine to deliver intelligent, personalized content recommendations and analytics. Knewton scales these operations by employing a service-oriented architecture, which allows its inference engine to reliably and efficiently process concurrent activity from tens of millions of students. Knewton provides analytics for teachers to help manage class learning, as shown in Fig. 3.

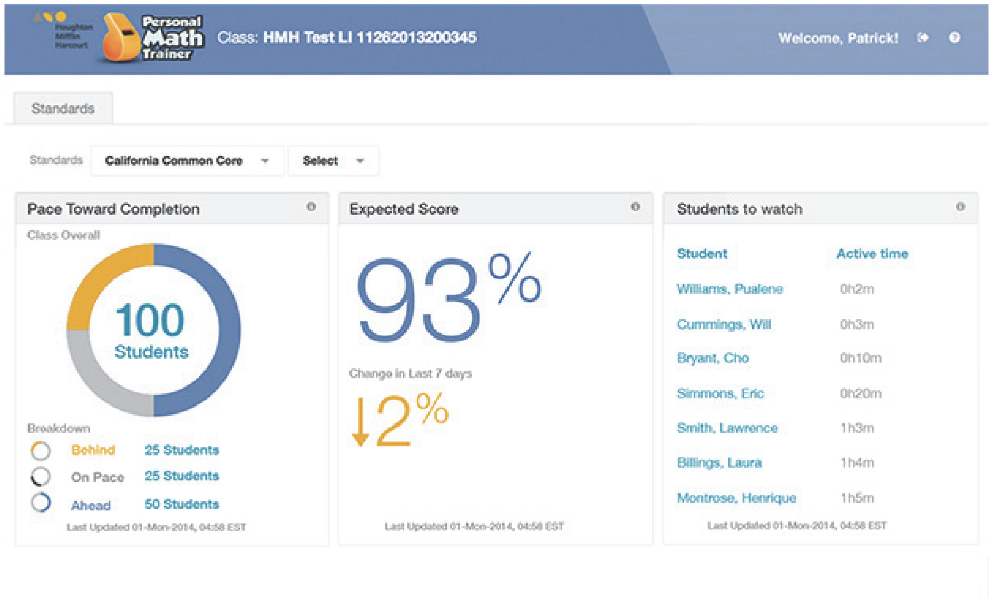

FIG. 3: Knewton Teacher Dashboard

6.2.1 Knewton Case Study 1: Arizona State University

Arizona State University (ASU) used Knewton technology to help more students succeed. Together, ASU and Knewton increased pass rates, reduced withdrawals, and advanced students faster through developmental math. With more than 70,000 students, ASU is the largest public university in the United States. As a research university committed to improving access to education, ASU was strained by the large number of enrolled students—each with diverse needs, interests, and educational backgrounds—who were not college-ready in mathematics, a key predictor of university success. ASU saw a high correlation between students who succeeded in developmental math and overall academic success. Students who earned an A, B, or C had 50% higher persistence rates (i.e., retention through graduation) than those earning lower grades. Unfortunately, more than 30% of students failed to receive a C or higher in ASU's developmental math course. The ASU developmental math students now use Knewton Math Readiness, a developmental math course powered by the Knewton platform and aligned with the Common Core Standards for Mathematics. As students work through online math lessons, Knewton analyzes vast amounts of anonymized data to figure out what a student knows and how they learn best. Then, Knewton recommends what concept in the course each student should study next, personalizing the educational experience and helping students at any level succeed. Knewton technology enables an entire class to work through material in a sequence and pace customized for each individual. As ASU's students progress through their developmental math course, the Knewton platform analyzes data behind the scenes to continually assess students' mathematical proficiency. Knewton then recommends what concept within the online course a student needs to work on next, creating a continuously updated and personalized learning path for each student. ASU's faculty used Knewton's real-time reports to detect gaps in knowledge, create adaptive study plans for each of their students, and focus lessons around concepts where students needed the most help. Students worked through the course at their own pace with their instructor's guidance. Instructors can see which students are off track, search for individual student performance metrics, or view trends across an entire group of students to determine which concepts are most difficult across the board. The course goal is to complete the requisite number of lessons at a certain performance standard. Each student must also pass a final exam administered by ASU. After two semesters of use with over 2000 developmental math students at ASU, course withdrawal rates dropped by 56% and pass rates increased from 64% to 75%. Almost half of students finished the course four weeks early, allowing them to advance immediately to the next level on mastering course concepts. This is an example of using an analytics-driven learning system such as Knewton to improve student outcomes.

6.3 CLASSROOM SALON

Classroom Salon (CS) is a learning content management system (LCMS) built around the concept of small learning groups called "salons." The platform is built around a familiar social media metaphor by providing message boards, real-time activity streams, and continuous assessment of how a student is functioning relative to other students in the class. For example, the Salon Engagement Score (Fig. 4) assess a student on four dimensions from student engagement (commenting activities), curiosity (asking questions), and helpfulness (responding to others questions) to consistency (how frequently student engage in learning activities). The score given in each category is a relative score indicating satisfactory (yellow), poor (red), and good (green). Based on the individual score, students can increase their activities in weaker areas to improve. The early evidence from a Princeton University based pilot indicates that student motivation to engage increases as they are provided with real-time analytics reports. Students used color-coded indicators as a way to improve the key areas such as course engagement, curiosity, helpfulness, and consistency.

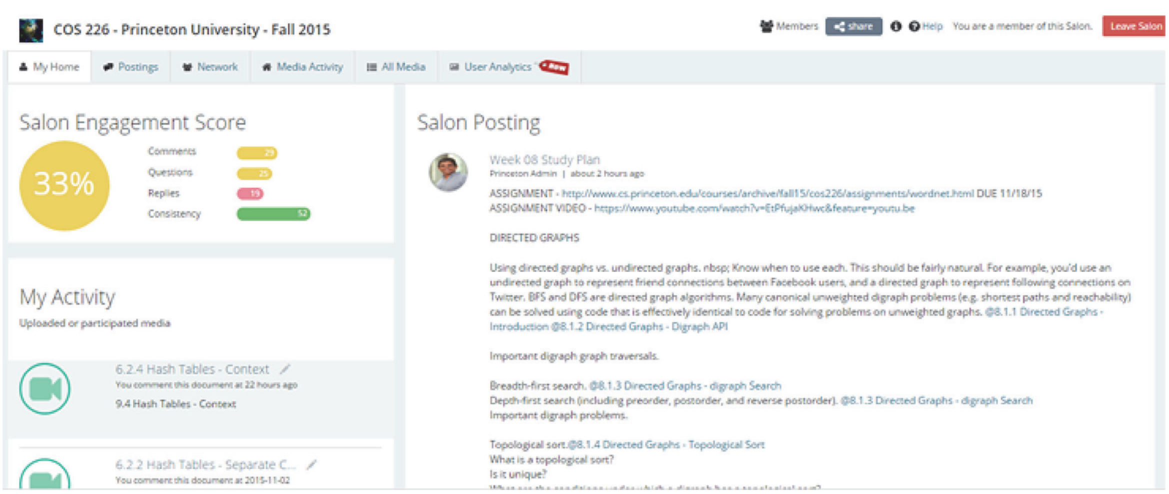

FIG. 4: Salon Home Page

CS takes a content-first approach to course design by recognizing that content, and how students interpret that content is one of the most important factors to consider in course design and delivery. For example, using local prompts (highlighted passages and video frames), instructors can engage students directly with content to improve communication and comprehension (Fig. 5). These data then can be used for improved instructional methods.

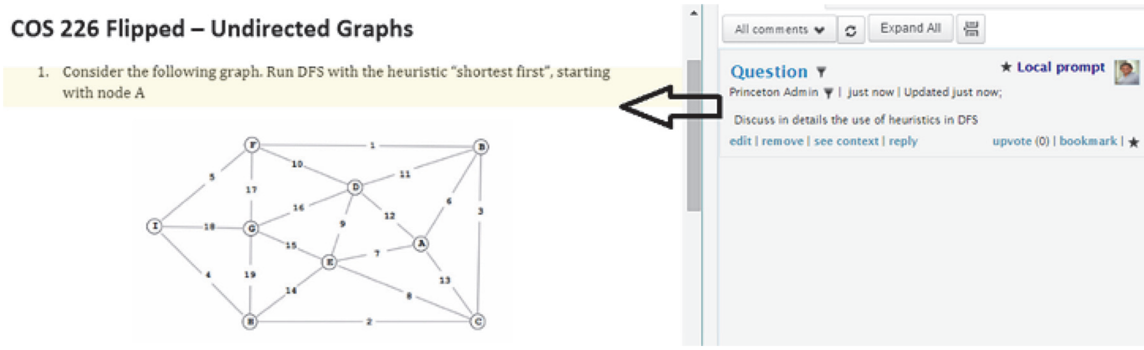

FIG. 5: An Example of a Local Prompt Presented as a Question

Students can highlight documents and annotate videos using instructor-defined tags such as "why I tagged this," "I do not understand," "I want to know more," or "I find this interesting," to indicate places of interest or confusion (Fig. 6). The tagging allowed easy categorization of content that needs to be further discussed and clarified in class.

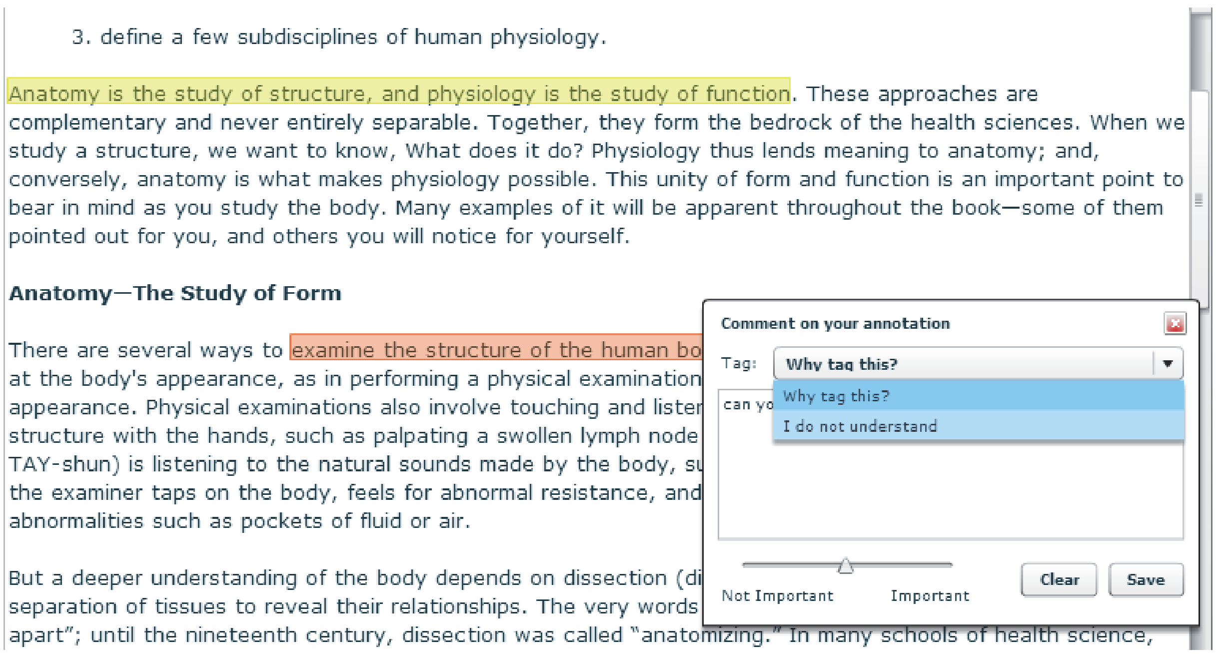

FIG. 6: Tagged Annotations to allow easy Classification

CS also encourages interaction among small groups of students that can form self-organized networks. Self-organized networks are dynamic groups that are self-selected by students themselves. Each student can work alone or as part of a self-organized group. Students can move in and out of groups, allowing them to find more compatible groups to join. Figure 7 shows a network of three students self-selected from 38 salon members. Instead of focusing on salon activities from all 38 members, students in the self-organized network can focus and learn from a smaller group of fellow students.

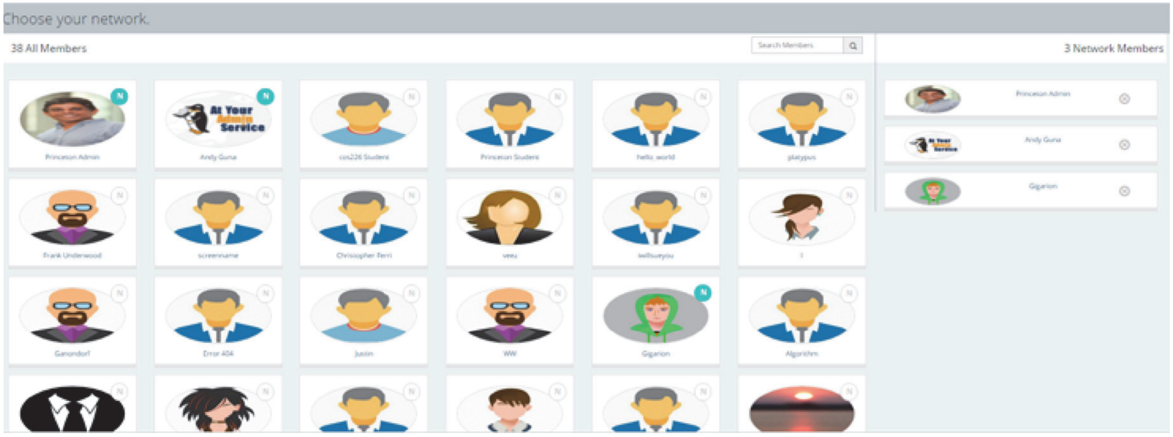

FIG. 7: Making Self-Organized networks

CS also aggregates student annotations (Fig. 8) and provide analytics reports that shows how student activities (red curve) compared to class activities (blue curve).

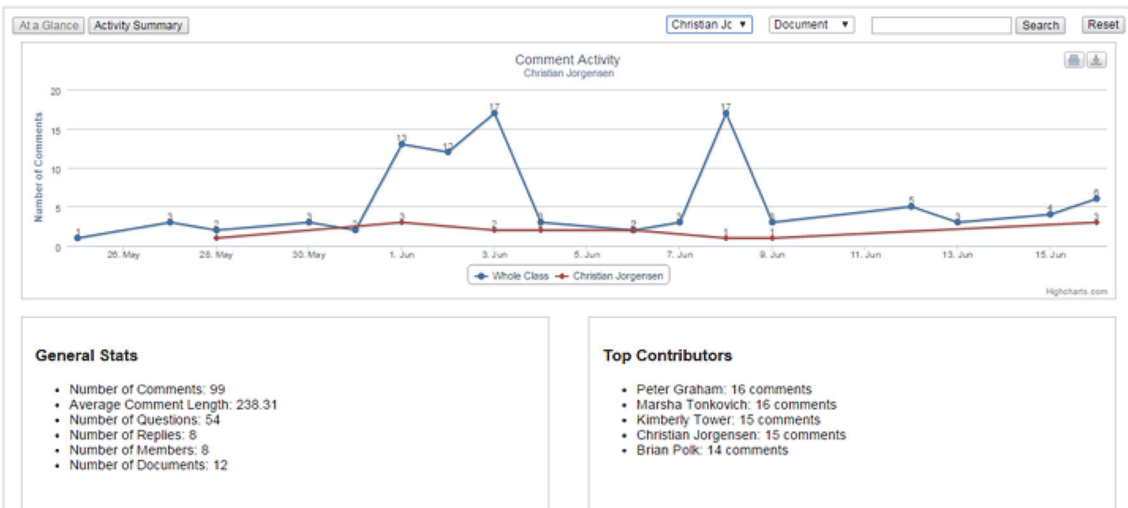

FIG. 8: Activity Timeline

A key challenge in data analytics is deciding how to interpret the data we see. Although many platforms provide data, educators often do not understand or have the time to interpret and use them for effective instructions. CS provides filters that can be used to quickly understand the important content based on social interpretation. For example, Fig. 9 shows how to filter annotations by 279 students to find hotspots or places of great interest. These hotspots then become the discussion topics in class.

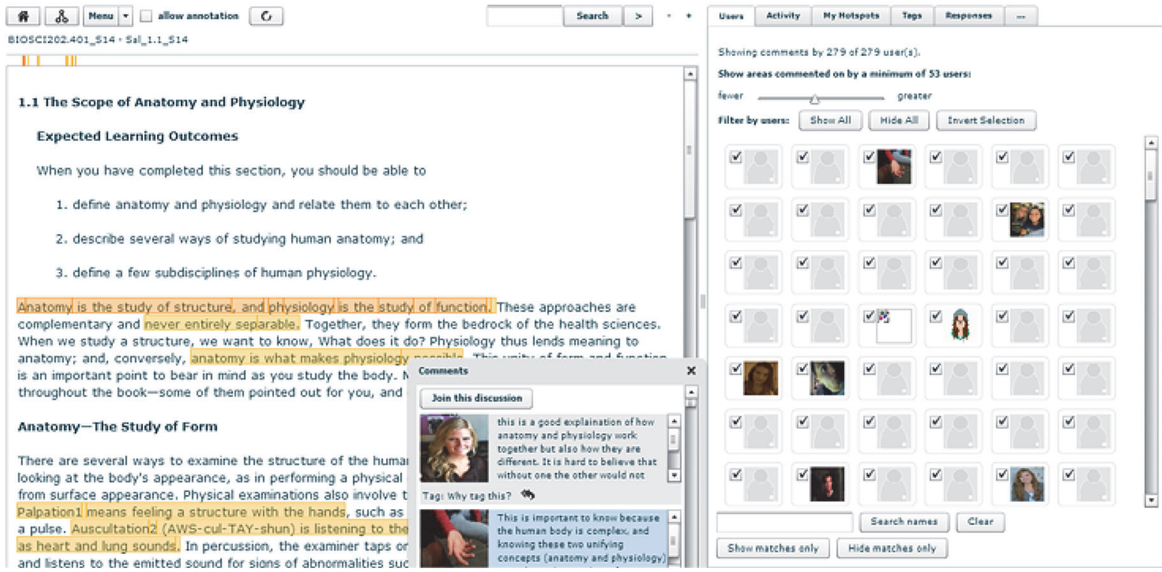

FIG. 9: Annotations Filtered by Hotspots

Modern analytics-driven systems (Knewton, 2008, Edmodo, 2008, CS, 2008) allow the design of the course based on what data are important to collect. For example, an instructor may decide to collect data on content that students found to be difficult. Instructors may also encourage social learning activities that can lead to data on how students interact with each other. In general, the design should take into account what analytics to collect and how to interpret them. It allows the teacher in charge of developing active engagement opportunities to understand how students comprehend course content. Tagging of content is another important area of analytics and discovery. For example, a tag distribution and user activity bubbles can indicate the need to address specific topics more than the others and to show which students are the thought leaders (bubbles in the middle of the chart) in the class (Fig. 10).

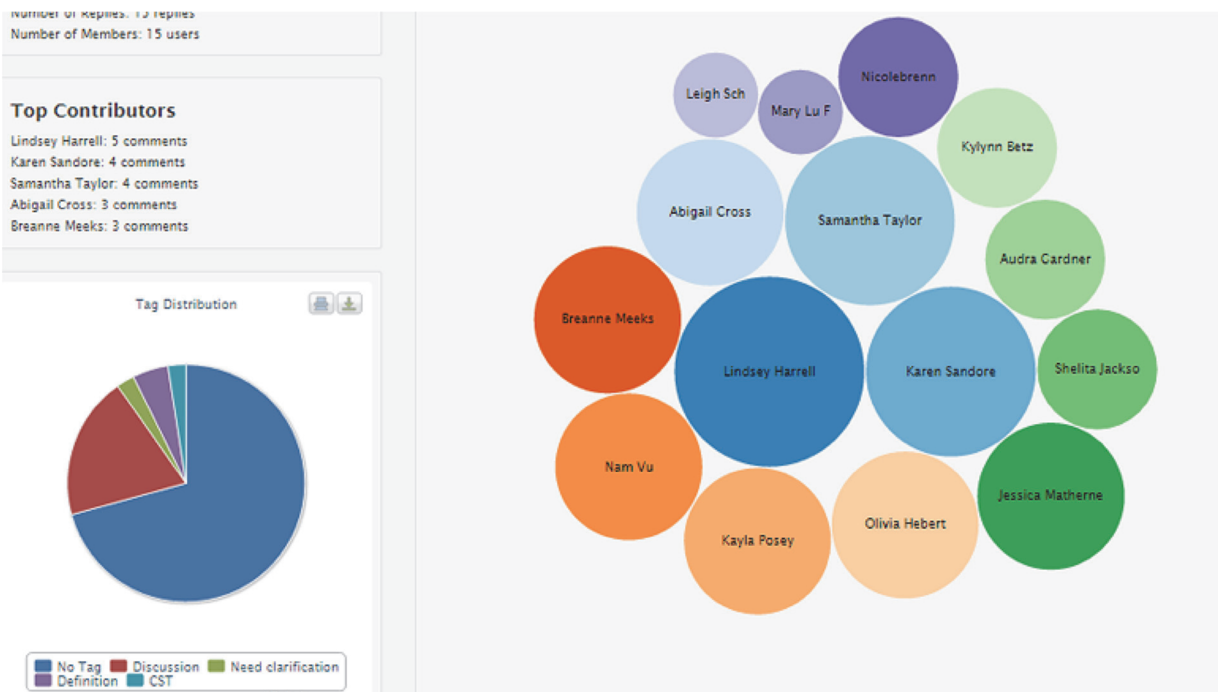

FIG. 10: Student Activity Chart on a Document

Figure 11 shows the participation and commenting trends in a specific document in CS (at a glance tab). The other tabs, such as user (Fig. 11), provide access to individual actions by each student as well as threads (Fig. 12) that were developed as part of the discussion.

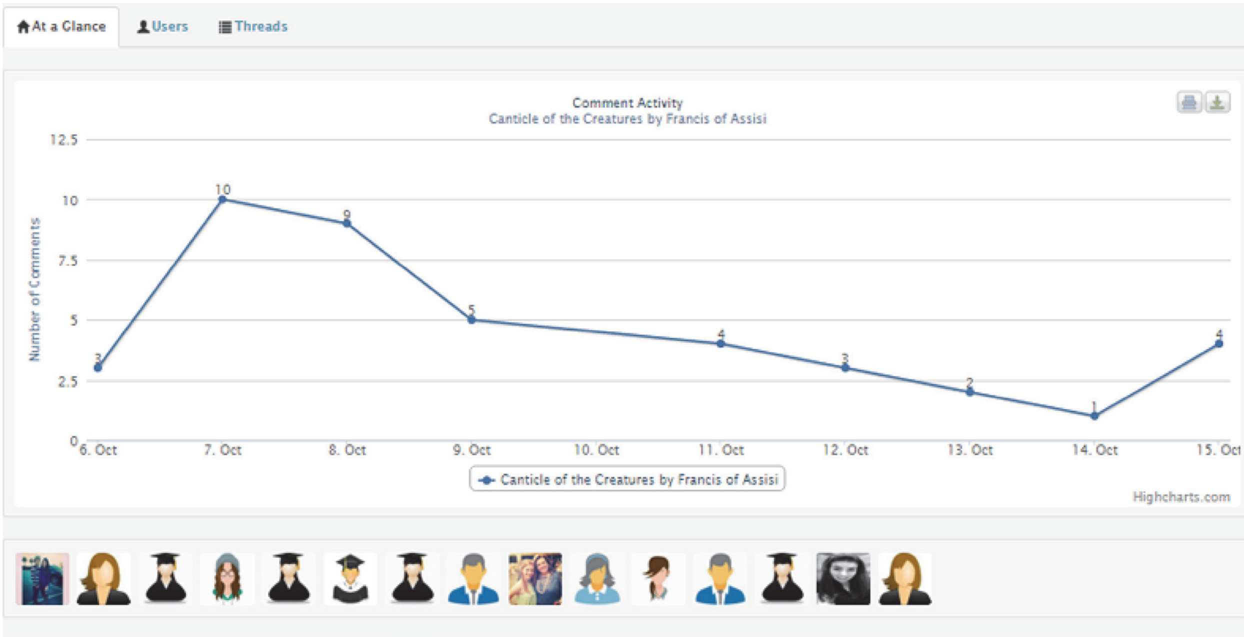

FIG. 11: Participation and Commenting Trends in a Specific Document

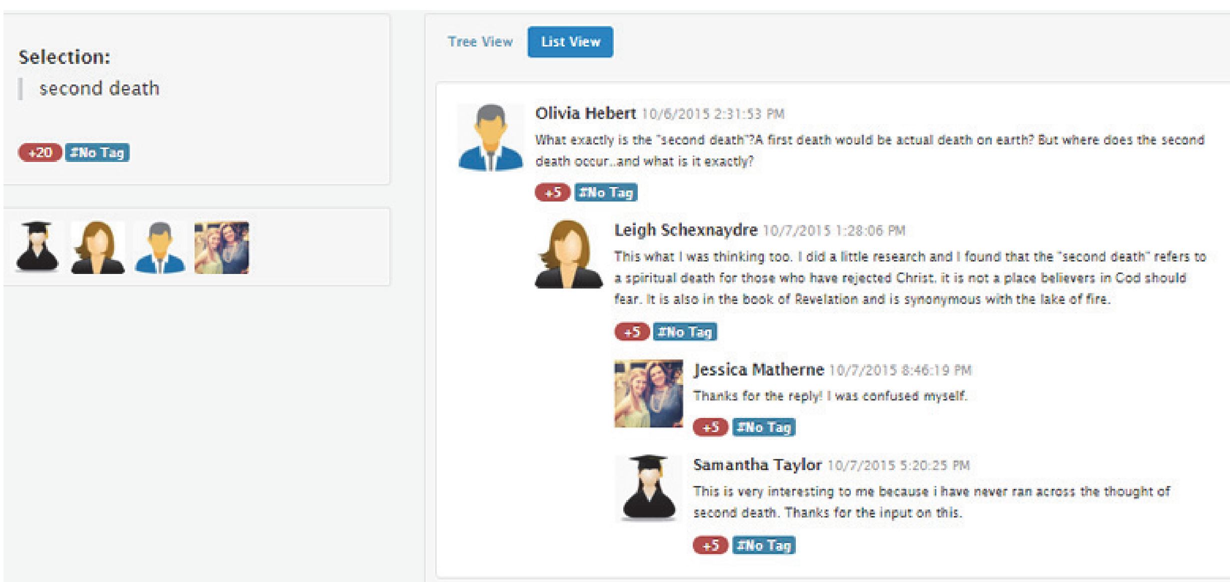

FIG. 12: Discussion Threads on selected text

6.3.1 Salon Case Study: University of Wisconsin-Milwaukee (Fig. 13)

In 2011, CS was introduced to the University of Wisconsin–Milwaukee (UWM) as part of an Educause/Gates Foundation grant (Gunawardena and Kaplan, 2013). The goal was to rethink two large introductory science courses in biology and chemistry, and to improve access and success rate of students in these classes. The project was an example of a novel use of analytics to deliver better instructions. The problem of overcrowded classes is very familiar in higher education today.

Overcrowded classes are not conducive to learning and instructors cannot simply provide any form of personalized attention to students. Hence, one of the best ways to scale education to large groups of students is to use analytics to understand the collective interpretation of course content and to provide customized instructions based on student annotations. In a biology class with nearly 600 students, each student was asked to read the book and annotate a few places to indicate where they find things interesting or confusing. Students were given participation credits for doing this activity of reading and annotations. Students do not see what others have selected while they annotate, and once the document is closed for annotations, instructor then can view the collective interpretation of content using CS tools. Figure 13 is an example of a sample chapter annotated by 279 students. Students annotated the text individually and the aggregated analytics are only available to the instructor.

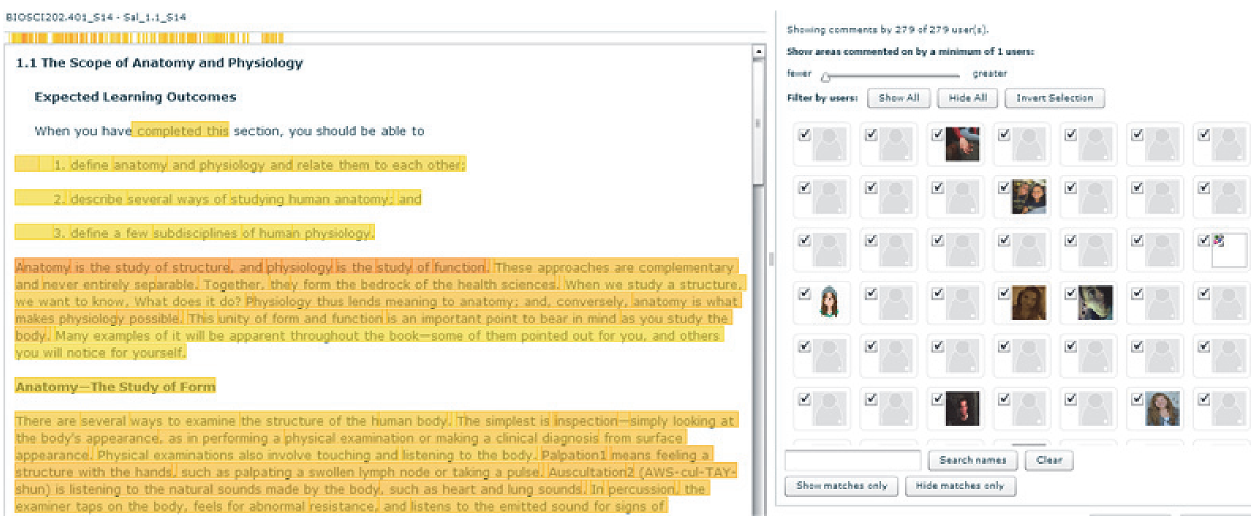

FIG. 13: A Sample Chapter Annotated by Large number of Students

Using a CS slider that allows the instructor to filter comments, the instructor can quickly focus on, for example, the places marked by a large majority of students (53+, as shown in Fig. 14). These sections then become the focus of discussion for the instructor and cliff notes of study for the student. Instead of teaching a generic set of topics to students, instructors can use CS to streamline instructions and answer the most pressing issues as shown by student annotations.

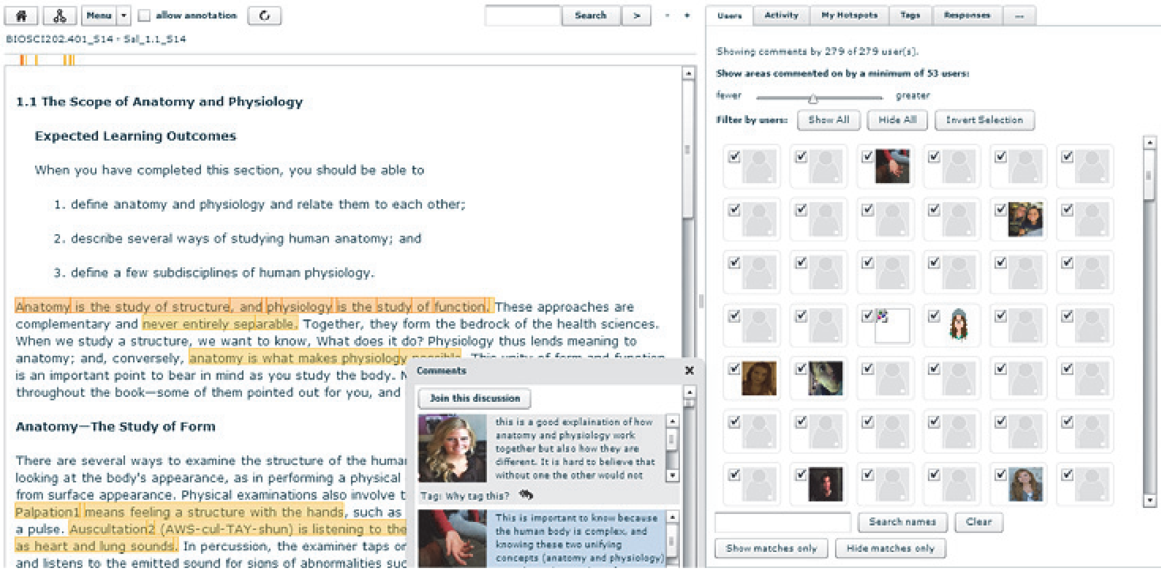

FIG. 14: Filtering Annotations to Visualize Common Hotspots of 53 or more students

6.3.2 Villanova University

Professor Markus Kreuzer teaches Political Science at Villanova University. His novel approach to using analytics include, a crowdsourced student assessments that draws from the large benefits of collaborative learning. It also eliminates the difficulty of managing student project groups. Students were able to contribute to the group discussion in three ways: posting sample answers, raising questions that seek to clarify aspects of the assignment, or asking for clarifications regarding some of the readings or videos that relate to the particular assignment. Students were also able to respond to posts by their colleagues and provide constructive, substantive feedback. Using CS analytics graphs, Professor Kreuzer was able to assess the progress, as shown in Fig. 15.

FIG. 15: The Activity Graph of the Mid-Term Group Discussion Document

Student contributions were evaluated in the following ways: number of posts, regularity of posts (i.e., posting a few comments on several occasions contributes more than posting a lots of comments on one occasion), how often student replied to other posts (i.e., this means that student is listening and providing feedback), how many people replied to their posts (i.e., this means that student raised important question that will help others), and number of up votes (indicates that others found their contributions helpful). Using CS analytics, the instructor was able to access valuable information on student engagement and persistence, as shown in Fig. 16. Each line in the following table corresponds to one student record.

Raw Scores				A) Group Contribution (50%) Rank Orders							
Number of Posts	Response % of posts	Avg. length of responses	Regularity	Number of posts	Responses as % of Posts	Avg.Length of Response	Disperson	Avg. Rank Order	Contribution Grade	Individual Assignment Grade	Difference:
16.0	81.3	51.3	2.9	8	3	16	6	6.0	B+	B+	0.4
26.0	73.1	43.3	3.6	5	8	17	2	2.0	A-	A-	0.0
14.0	64.3	23.3	6.3	12	9	19	1	1.0	B	B	0.3
13.0	46.2	58.8	3.4	13	13	14	4	4.0	B-	C+	1.2
12.0	16.7	69.5	1.9	14	18	4	12	12.0	B-	C+	0.8
15.0	26.7	33.8	1.0	11	16	18	18	18.0	C	C-	0.9
					20	20		#DIV/0!			2.9
27.0	63.0	60.9	2.5	4	10	13	11	11.0	B	B	0.6
30.0	86.7	69.3	3.4	3	2	5	4	4.0	A	A	-0.2
17.0	47.1	94.6	2.5	7	11	1	11	11.0	A	A	-0.5
8.0	25.0	62.0	1.9	18	17	12	12	12.0	C	C-	0.3
38.0	73.7	56.6	3.4	1	6	15	4	4.0	A	A	-0.2
11.0	45.5	87.0	3.5	15	14	3	3	3.0	B+	B+	-0.2
8.0	12.5	67.0	1.3	19	19	6	16	16.0	C	C-	-0.2
15.0	73.3	63.9	1.6	10	7	9	15	15.0	B	B	0.7
9.0	33.3	64.0	1.0	17	15	8	19	19.0	C	C-	1.1
5.0	46.0	67.0	1.9	19	14	1	12	12.0	B-	C+	1.1
10.0	90.0	63.9	2.8	16	1	10	7	7.0	B+	B+	-0.1
35.0	74.3	66.3	1.1	2	4	7	17	17.0	A	A	-0.2
15.0	46.7	91.7	3.2	9	12	2	5	5.0	A	A	-1.0
9.3	41.3	65.5	1.5	6	5	11	15	15.0	B	B/B+	0.2

FIG. 16: The Class Activity Table

As students discuss content more, they lead to conversation structures that can lead to self-organizing groups. These groups can then work more efficiently to provide better outcomes. Once again, this was made possible by deep analytics from CS that discovers latent relationships among students (Fig. 17).

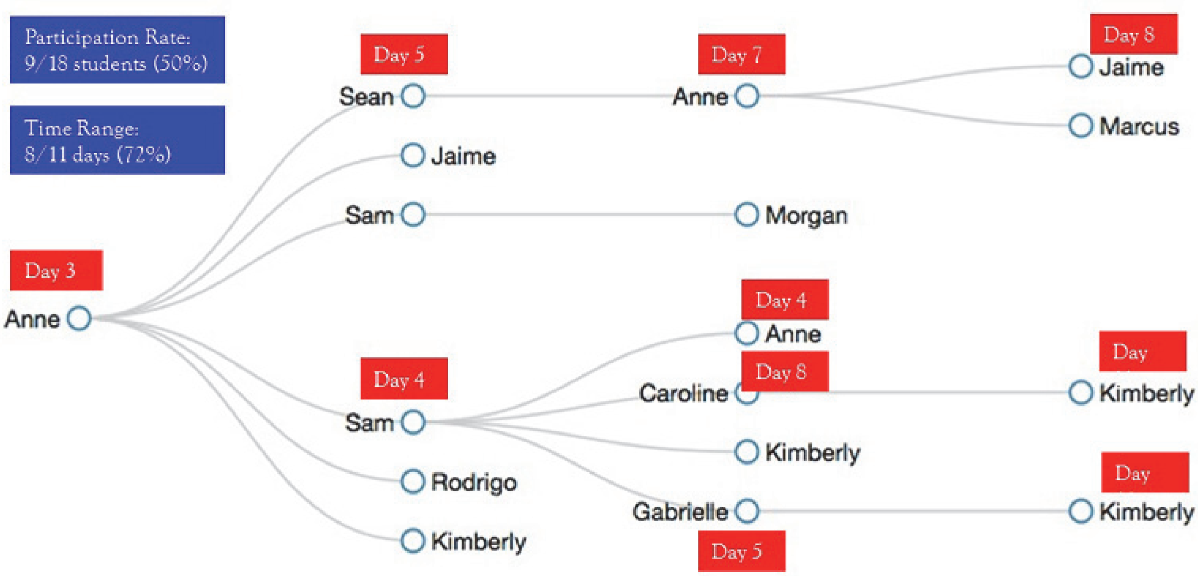

FIG. 17: A conversation tree as shown by CS analytics

The use of analytics in his course made better understanding of student behavior and latent group behavior patterns that are difficult visualize without the aid of technology.

Figure 18 shows student engagement in the salon, and the data were used by a predictive analytics model to help instructors understand the student's potential for success or risk of failure, well in advance. Another benefit to these types of analytics was that it enabled the instructor to measure intangibles such as leadership, helpfulness, engagement, and consistency of participation, all of which are critical indicators of student success or risk of failure.

FIG. 18: Participation bubble of each student

6.3.3 Princeton University

In spring 2015, Princeton University used CS as the platform to deliver a computer algorithms course. A flipped lecture was offered as an alternate to traditional lecture. While traditional lecture students met twice a week, flipped students met only once a week. Flipped students were responsible for watching instructional videos, responding to questions, and commenting on places of interest. The analytics generated from student interactions were critical to the success of the flipped model, despite the fact that it only had one meeting per week. For example, the instructor was able to access the tag distribution prior to the class to understand which sections needed to be discussed further (Fig. 19).

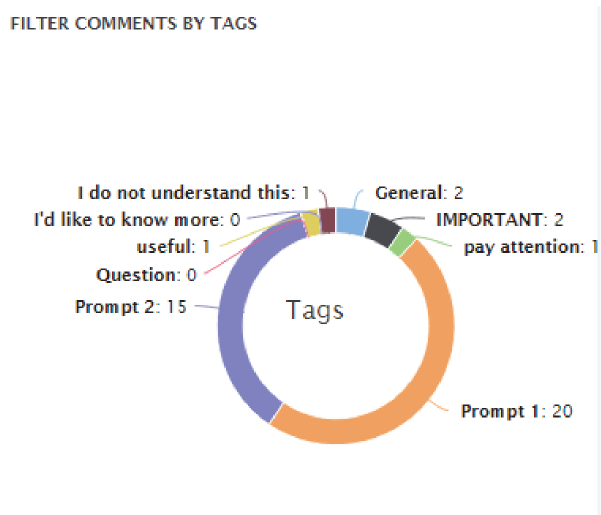

FIG. 19: A tag distribution of comments

Moreover, the course analytics showed (Fig. 20) how a particular concept was actively accessed by students compared to all activities. As shown in the graph (red line), the video of "11.3 binary search trees—deletion" was only accessed by students during a limited period, indicating less importance or triviality of the concept to students. On the other hand, some content videos were accessed throughout the semester and hence were important to be discussed during final exams and review sessions. The experiment was conducted using two groups, namely, one group who attended traditional lectures and another group who met only once a week and mostly learned from videos and using CS. The analysis of data indicated that the learning outcomes from two groups, traditional (n = 208) and flipped (n = 23), were almost identical (Fig. 21) indicating that it is possible to obtain similar learning outcomes by combining less human resources and using deep analytics.

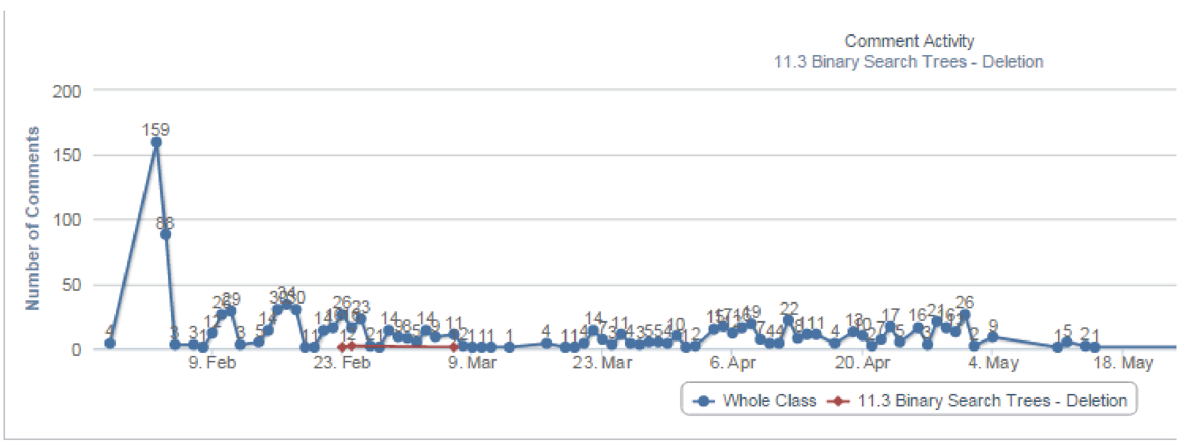

FIG. 20: Access patterns of a specific video during a semester

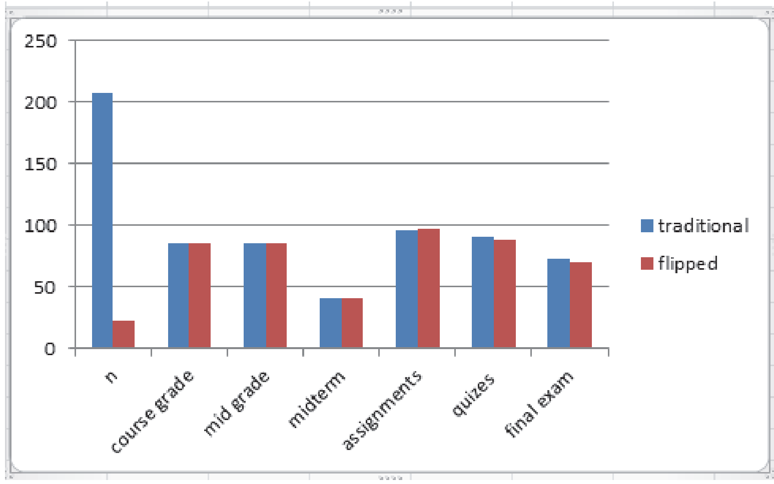

FIG. 21: A comparison of performance in analytics driven flipped class (red) versus traditional class (blue)

7. FUTURE POTENTIAL FOR ANALYTICS-BASED EDUCATION

We conclude this paper with a discussion of the future potential for analytics-based education. Analytics, or the effort to create interpretation from data, will continue to get attention from educators and administrators throughout the world. Learning analytics help revise curriculum, provide better teaching, and improve assessment in real time (Johnson et al., 2011). More and more learning management systems will provide dashboards that can be used to get a snapshot of the state of a course. Systems like Purdue University based Course Signals (Course Signals, 2009) or Carnegie Mellon University based Classroom Salon (Classroom Salon, 2008) will alert instructors when a student is falling behind. The intelligent tutoring system based platforms like OLI (Open Learning Initiative, 2001) will continue to guide the learners through a path based on what the system thinks is the next best thing to do to advance. Innovations in analytics in education will come from individual instructors who can now use modern tools such as Classroom Salon, Edmodo, or Knewton to design, deliver, and use the data to improve instructions. Sometimes, the interpretation of data at the macrolevel can be difficult. Therefore, third party predictive analytics companies will provide services to educational institutions that are trying to interpret the data. For example, in one recent study at American Sentinel University, the data predicted that if a student completes half the curriculum, they are 99% more likely to complete the degree. This is valuable data to the institution to minimize student dropouts by providing more support during the first half of their study. There is no magic bullet in educational analytics. Creating a better learning environment and obtaining good outcomes is a complex task. When a student fails a course, or does not submit an assignment, or does not attend class, the reasons can be much more complex than just the educational data analytics. But educational analytics provide a way to “know” without any formal assessments. Sometimes it is better to know than to measure. Formative assessments like tests and quizzes do not always tell the whole story. Instead, student data must be available on a daily basis and data must be more granular than just the login time to a system or access of course media. We need to know what documents students are accessing and how they are consuming them. The “how” question is more important than what they access. We believe educational platforms will evolve to provide more comprehensive and continuous data. Classroom Salon, Edmodo, and Knewton are some examples, where each day students are informed of where they stand in the class compared to class average. In CS, for example, instructors know what content pieces students really care about or have difficulty understanding. In flipped classes, the role of analytics becomes even more important. If the instructor knows which sections students are having trouble with, those concepts can be addressed effectively and efficiently. The key is to capture good data that can help display hotspots of activities. One key question that still needs to be addressed is the privacy of data. How can we balance privacy while using data to make good teaching decisions and help students navigate through courses?

One other thing is clear. With the availability of Google, Wikipedia, and YouTube, we no longer understand how or when students really "learn." Therefore, future educational systems must find ways to integrate with other data sources such as Google, Wikipedia, or YouTube to create a more global picture of the learner.

All in all, we think that analytics-driven learning will dominate education in the coming years. It will allow faculty resources to be efficiently allocated to teaching and learning. Analytics can only create better outcomes in education and we remain hopeful that analytics will significantly drive educational outcomes and reduce the cost of education. We encourage educators to innovate on how they use analytics in their teaching. As you invent new ways to teach using analytics, submit a paper to this journal to be published in the future.

REFERENCES

Arnold, K.E., Signals: Applying Academic Analytics, *EDUCAUSE Quarterly*, vol. **33**, no. 1, http://bit.ly/29WeYDw, 2010.

Blackboard Learn, http://blackboard.com, 1998.

Blecking, A., Classroom Salon – An Innovative Method for Investigating Student Learning, http://pubs.acs.org/doi/pdfplus/10.1021/bk-2014-1182.ch010, 2014.

Brown, M., Learning Analytics: The Coming Third Wave, *EDUCAUSE Learning Initiative Brief*, http://bit.ly/29UlpWk, 2011.

Campbell, J.P., Oblinger, D.G., *Academic Analytics*, EDUCAUSE white paper, http://bit.ly/2a16GdZ, 2007.

Classroom Salon – Interpretation is social, http://classroomsalon.com, 2008.

Cloud Computing in Education, http://bit.ly/12uN233, 2014.

Course Signals, Teaching and Learning Technologies, Purdue University, http://www.itap.purdue.edu/learning/tools/signals/, 2009.

CourseSmart, online textbooks and course materials, http://www.coursesmart.com/, 2007.

Dawson, S., McWilliam, E, Tan, J.P., Teaching Smarter: How Mining ICT Data Can Inform and Improve Learning and Teaching Practice, in *Hello! Where Are You in the Landscape of Educational Technology?* Proceedings ascilite Melbourne, http://bit.ly/2ahpffM, 2008.

eCollege – http://ecollege.com, 1996.

Edmodo – Connect with Students, http://edmodo.com, 2008.

Gates Foundation, http://www.gatesfoundation.org/, 2000.

Google: Computer Science Capacity Awards, http://bit.ly/29O5fgh, 2015.

Gunawardena, A., Kaplan, N., A Socially-Centric Blended Learning Model for at Risk Youths in an Urban Institution, Project funded by Next Generation Learning Challenges, http://www.cs.cmu.edu/~ab/Salon/research/uwm/final%20report%20of%20classroom%20salon%20implementation%20at%20UWM.pdf, 2013.

Hawkins, B.L., Accountability, Demand for Information, and the Role of the Campus IT Organization, in R. N. Katz (Ed.), *The Tower and the Cloud*, pp. 98–104, 2008.

Johnson, L., et al, Horizon Report. 2013 Higher Education Edition, http://bit.ly/2a9QoQB, 2013.

Johnson, L., Smith, R., Willis, H., Levine, A., Haywood, K., *The 2011 Horizon Report*, Austin, TX: The New Media Consortium, http://bit.ly/2a17bES, 2011.

Kaufer, D., DocuScope: Computer-aided Rhetorical Analysis, https://www.cmu.edu/hss/english/research/docuscope.html, 1998.

Knewton – An Adaptive Learning Company, http://knewton.com, 2008.

Lee, M.H., Runde, J., Jabril, W., Wang, Z., Brunskill, E., Learning the Features Used to Decide How to Teach, *Learning at Scale 2015*. Work in Progress paper, 2015.

Luan, J., *Data Mining Applications in Higher Education*, SPSS Executive Report (DMHEWP-1004), http://bit.ly/29UlSrK, 2004.

Ma, J., Han, X., Yang J., Cheng, J., Examining the necessary condition for engagement in an online learning environment based on learning analytics approach: The role of the instructor, Internet and Higher Education, vol. **24**, pp. 26–34, 2015.

Norris, D., Baer, L., Offerman, M., A National Agenda for Action Analytics, *National Symposium on Action Analytics, St. Paul, MN*, September, 2009, http://bit.ly/29ZNVs9.

Open Learning Initiative (OLI), Carnegie Mellon University, http://oli.cmu.edu/, 2001.

Piazza, Q&A platform, https://piazza.com, 2011.

van Barneveld, A., Arnold, K.E., Campbell, J.P. Analytics in Higher Education, *EDUCAUSE Learning Initiative*, ELI Paper, 2012.

Wankel, L., Blessinger, P., *Increasing Student Engagement and Retention using Online Learning Activities*, ISBN 978-1-78190-238-7, Emerald Group Publishing: United Kingdom, 2012.

Wikipedia, https://en.wikipedia.org/wiki/Analytics, 2001.

Wikipedia, Business Analytics, https://en.wikipedia.org/wiki/Business_analytics, 2001.

MOOCs AS AN INNOVATIVE PEDAGOGICAL DESIGN LABORATORY

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Abstract

Increased demand for online learning options coupled with the pace of the evolution of technology and pedagogy has necessitated growth in the quality and quantity of facilitation training for online faculty to support effective educational experiences. Based on data presented in a variety of reports on MOOCs, the participants tend to primarily be people with master's degrees or higher, so it makes sense to use MOOCs as multi-institutional professional development for educators who teach online. These digital learning spaces can bring educators together to explore new pedagogical techniques that can have a positive impact on their teaching practice. This paper will explore one such course, Humanizing Online Instruction, which was designed to allow instructors to learn the principles of a community of inquiry while exploring the use of social media and asynchronous video to enhance presence (instructor, social, and cognitive) in online courses.

KEY WORDS: MOOCs, pedagogy, social media, audio and video recording, community of inquiry, instructor presence, social presence, cognitive presence

Whitney Kilgore, chief academic officer of iDesignEDU and PhD candidate at the University of North Texas, has an extensive background in educational leadership, educational technology, strategic planning, learning management systems, professional service delivery, and organizational change. Her primary areas of research are faculty professional development, humanizing online instruction, and increasing learner engagement. She recently keynoted at the University of Texas System's Innovation in Online Learning conference, presented at the European

MOOC Stakeholder's Summit, and has been selected to speak at the Digital Learning Research Network Conference at Stanford.

She previously served as vice president of Academic Services for Academic Partnerships (AP). In this role, Kilgore was responsible for the planning, development, and assessment of AP's domestic and international partner universities' high-quality online degree programs (in the United States, Latin America, the UK, China, Australia, Spain, and the Philippines). Prior to joining Academic Partnerships, she worked for SunGard Higher Education from 2006 to 2011. During that time, she served as director of academic technology at the College of Southern Nevada, where she led the expansion of the online campus as it grew larger than any of the brick-and-mortar campuses, serving 46,000 students with 30 fully online degree programs.

Maha Al-Freih is a lecturer of educational technology at Princess Nora University, Riyadh, Saudi Arabia. She received a BS in computer science from King Saud University, Riyadh, and MA in teaching and learning with technology from Santa Clara University, California. During her time in Saudi Arabia, she provided technology training for the Institute of Banking and Alyamama University as well as faculty training workshops on the integration of social media in teaching and learning at Princess Nora University. In addition to teaching and technology training, she has participated in a number of national and international conferences.

Al-Freih is currently pursuing a PhD in learning technologies design research with an emphasis in instructional systems design at George Mason University in Virginia, where she also works as a graduate research assistant. She recently designed, developed, and delivered a workshop on portfolio creation using Google sites, Twitter, and blogs to 50 in-service teachers at the Virginia Center for Teaching Excellence at George Mason University. Her primary research interests include learners' engagement and persistence in massive open online courses (MOOCs), personal learning environments (PLEs), self-regulated learning (SRL), learning analytics, and design-based research (DBR).

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1. INTRODUCTION

In 2008, a new learning model emerged in the e-learning landscape and attracted the attention of educational researchers, designers, instructors, and students, namely, massive open online courses (MOOCs). The acronym highlights its key components: massive, there is no limit on attendance; open, free of charge and accessible to anyone with Internet connection; online, delivered via the

Internet; and course, structured around a set of goals in a specific area of study. MOOCs stand out because of their unprecedented scalability and open access, which challenge many held conventions about formal learning. While the novelty and scalability of MOOCs pose new challenges to researchers and practitioners within the educational community, they also serve as a rich ground for experimenting with innovation at scale.

Most of the discussions about MOOCs distinguish between two different formats, often referred to as connectivist MOOCs, or cMOOCs, and instructivist MOOCs, or xMOOCs. cMOOCs are based on connectivist pedagogy and emphasize the learning journey defined by the connections learners create between resources and with a distributed network of peers by harnessing the power of social media (Bates, 2014). Consequently, social media tools that foster connections, co-creation, and sharing constitute the course platform. Siemens (2004) outlines the following principles of connectivism:

- Learning and knowledge rests in diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in nonhuman appliances.
- Capacity to know more is more critical than what is currently known. "Know where" replaces "know what" and "know how."
- Nurturing and maintaining connections is needed to facilitate continual learning.
- The ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (up-to-date knowledge) is the intent of all connectivist learning activities.
- Decision making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

xMOOCs, which emerged in 2011 and are usually offered by prestigious universities, are predominantly associated with the cognitive-behaviorist theories of learning and teaching and emphasize individual learning rather than learning with and through peers. Learning in these online courses is primarily based on lectures, videos, texts, quizzes, and peer assessments (Bates, 2014). Videos in these online courses are instructional in nature and designed and produced for individual consumption, reflecting an outdated mode of video usage in the classroom. Consequently, the focus of these instructional videos has been on production quality rather than the pedagogical aspects of using videos for learning purposes (Bates, 2014; Zahn et al., 2014).

There has been an increase in the use of social media for personal and professional purposes by higher education faculty in recent years. However, not all social media tools and sites are used equally in the classroom. In a recent survey (Moran et al., 2011), faculty in higher education indicated that online videos are by far the most common type of social media used in their classrooms followed by podcasts and blogs. Videos in the classroom, whether for teaching purposes or as part of student assignments, were used by 80% of faculty who indicated any use of social media in their courses. Despite this increase in social media use in teaching and learning, and the potential value faculty see in many social media tools in the classroom, they still reported some barriers to technology adoption including the amount of time it takes for effective integration of social media for learning as well as privacy and integrity concerns (Moran et al., 2011; Roebuck et al., 2013).

With the increase in video usage in the classroom and the potential impact it might have on teaching and learning, a number of researchers have begun to investigate and share effective practices that can support student learning. Some of the strategies reported in the literature include the use of videos to stimulate discussion among students and including videos that present opposing arguments as a way to engage students in deeper learning by critically analyzing opposing views and synthesizing their own conclusions (Tan and Pearce, 2012). This suggests that a more active and social use of videos is beneficial and results in the development of higher-order thinking skills.

Clearly, support for faculty regarding the use of social media tools in general and videos specifically is needed to support the effective integration of these tools in the classroom. The purpose of the HumanMOOC was to provide this support for faculty and others interested in the use of social media tools for learning and/or training. The focus of the HumanMOOC extended beyond the mere development of these videos to sharing innovative strategies for how these tools could be used to support deeper learning. Our goal in the HumanMOOC, described in more detail below, was to incorporate video activities as a tool to foster reflective learning that empowers learners to share their thoughts and ideas rather than passive watching.

2. INNOVATION

The cMOOC drew attention to the use of social media and the open web to help connect educators and develop community online around specific topics of interest. Prior to the arrival of the xMOOC in 2011, there was very little attention paid to producing high-quality video in online courses. The MOOC phenomenon has had many impacts on teaching and learning online and significantly changed the expectations of students, faculty, and administrators about what a good online course contains or looks like, however, the engagement of the learners is often questioned in the news and research (Koller et al., 2013). As the Web becomes more and more video based, how can this innovation be leveraged within online learning experiences to enhance understanding, engage learners, and create a sense of presence and connection that text simply cannot do? An open course creates a space for innovative educators to connect, share, and explore new methods and tools in order to improve their practice.

3. MOOC ITERATION AS A REFLECTIVE PROCESS: THE HUMANMOOC

In 2011, xMOOCs rose from the laboratories of computer scientists who brought a machine learning approach to education (Fazackerley, 2012). These xMOOCs were best known for their re-creation of the lecture as video, computer-graded assessments, and very little to no interaction with the professor. While technology can certainly enhance some aspects of learning, researchers have written about the sense of loneliness that online learners experience. The lack of human connections in these courses has been reported in the literature as one of reasons for high attrition rates in MOOCs (Kop et al., 2011).

The HumanMOOC design focused on creating opportunities for intellectual exploration that ultimately benefits society rather than knowledge dissemination. Therefore, the HumanMOOC design team gathered to discuss the impacts that xMOOC models of delivery could have on online education if online instructors perceived these as possible examples of quality and value. While we applauded the achievements of these scientists in their development of more efficient systems, we had serious concerns about pedagogy and learner support.

4. DUAL-LAYER DESIGN

The design intent of the HumanMOOC was to create a community space where ideas could be shared and new thoughts about teaching and learning are generated and discussed. The description of the course made it clear that instructors who teach online from multiple institutions and many disciplines would be the ideal candidates for the MOOC. The Canvas Learning Management system hosting the course served as the embedded learning space for the learners to share their thoughts and ideas. This space became the private “members-only” sharing community for participants who were not comfortable sharing their ideas and comments out on the open Web. However, in true connectivist fashion, we also encouraged participants to share their learning openly using blogs, Twitter, and other technology tools, which we called exoskeletal learning. Using a dual-layered design (Crosslin and Dellinger, 2015) our embedded and exoskeletal approach was utilized in the format and structure of the HumanMOOC learning environment.

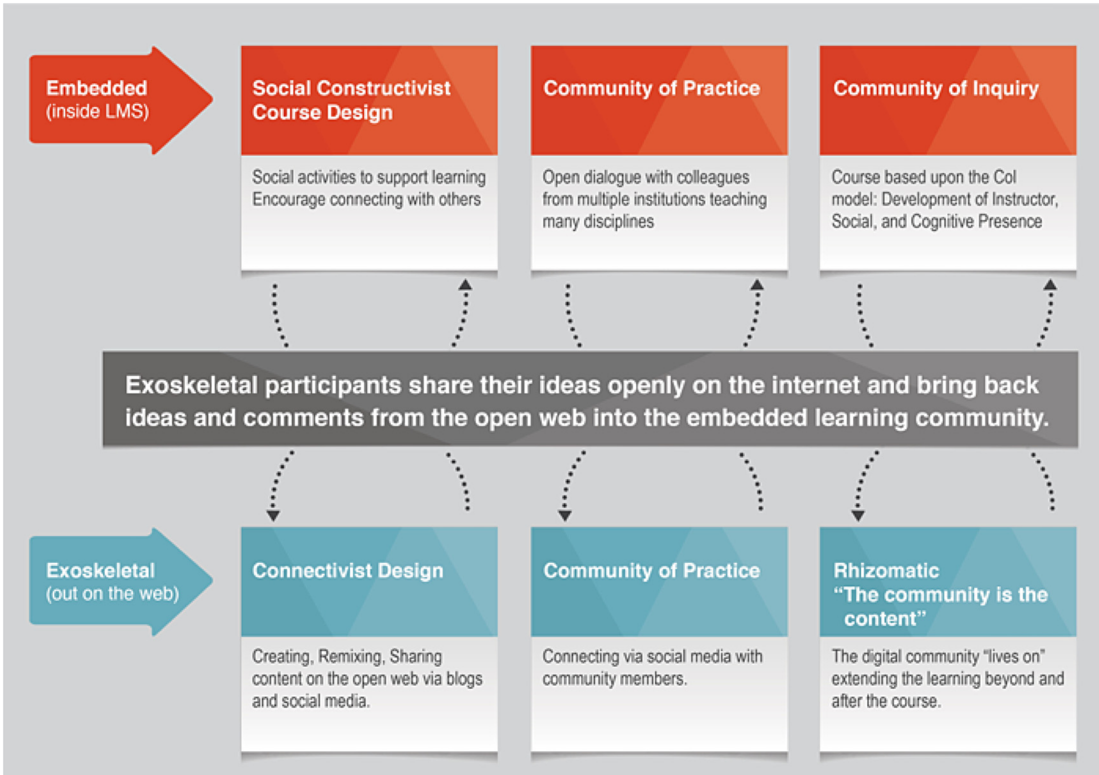

FIG. 1: Dual-layer (embedded/exoskeletal) design

Inside the learning management system (LMS), tucked away from the open Web, was a rich learning community who came together to learn about the community of inquiry (CoI). Within the course, each week was designed to focus on the various online presences of the CoI framework (teaching, social, and cognitive). The learning design inside the LMS was social constructivist, where participants learn by "doing." The HumanMOOC community brings together thought leaders who are passionate about the topic of humanizing online instruction. Wenger et al. (2002) discusses designing for communities for "aliveness," as all communities require interaction in order to become living, collective repositories of knowledge. This design allows for "participating in group discussions, having one on one conversations, reading about new ideas, or watching experts duel over cutting edge issues. Even though communities are voluntary and organic, good community design can invite, even evoke, aliveness by advocating relationship building, collaborative learning, sharing of knowledge and best practice, and networking among colleagues" (Wenger et al., 2002, p. 4). Wenger (1998) affirms that negotiated meaning is not the same as starting from scratch but rather is a collaborative and productive learning process. This new negotiated meaning is useful due to its uniqueness and the collaborative nature by which it is created. Hence, a Community of Practice (CoP) is not something that can be designed for, but rather is something that evolves with a group around their particular needs and for purposes that they value as meaningful (Wenger, 1998). However, understanding the social dynamics and learning processes of learning communities and how technology supports such actions can help instructional designers articulate and implement design principles that evoke and nurture the development of such communities.

In the exoskeletal portion of the course, an intentional connectivist design to the learning experience is observed. For those who participate in the exoskeletal layer the learning is more rhizomatic, where the community is the content (Cormier, 2008). It is this intentional community cultivation through live events, regular announcements, discussion posts, blogging, Twitter chats, and more that helps to maintain the connectedness. These events allow the participants to stay informed, to continue communicating, and remain connected to each other.

When designing a MOOC for unknown participants, it is important to assume that everyone will enter the MOOC with various levels of background knowledge and experience (Macleod et al., 2014). This variety creates a serious challenge for the design team who must create structured learning experiences for novice learners while ensuring more personalized learning pathways that induce critical thinking for more advanced learners. Course materials inside the LMS are designed as a scaffolded social constructivist course that can stand alone; however, elements that engage learners in connectivist learning are found outside the LMS in most cases.

5. CONNECTIVISM AND COURSE DESIGN IMPLICATIONS

There is no clear typical learning design of a cMOOC (Bates, 2014). This type of MOOC can be loosely structured by the week, and courses are open, messy, and lack a clear method of assessment of learning outcomes since the objectives or learning goals are defined by the learner (Kopet al., 2011; Stewart, 2013). cMOOC learners often state that cMOOC courses lack a coherent structure or summary of learning and describe them as chaotic. Researchers have found cMOOC courses provide fuzzy or messy learning opportunities with flexible, open, disruptive, unpredictable tasks that create tension and anxiety that are an essential part of the transformative process (deWaard et al., 2011; Kop et al., 2011). These concerns regarding connectivism and the chaos of messy learning are addressed in the embedded design of the HumanMOOC, yet messy learning is strongly encouraged in the exoskeletal layer of the course. While the course is structured in a very linear, logical, and weekly format, it is anticipated that the learning will stretch far beyond the LMS into the blogosphere and beyond.

6. SOCIAL AND MOBILE

Social media tools are essential to MOOCs as they promote connectivity, communication, and interaction (deWaard et al., 2011). They also increase course enrollment through social networks as friends and colleagues recommend the course to one another (Stewart, 2013). Learners also use mobile phones to access materials and learning via the Internet at an increased rate (deWaard et al., 2011; Williams et al., 2011). Williams et al. (2011) believed learning spaces should be designed to allow flexibility and self-organization because even when learners are in a face-to-face environment, most learning takes place outside of the classroom.

Interaction and dialogue in an MOOC are central to learning design because the network of learners shares how they have created knowledge, and knowledge creation is central to the learning process (Couros, 2009; Milligan et al., 2013). This social sharing provides a sense of social presence or connectedness that enhances learning and helps learners create meaning through discourse (Kop, 2011). The ability of learners to create knowledge and share it online is a very different model of learning from the traditional model where the learner passively absorbs knowledge from the teacher (deWaard et al., 2011; Stewart, 2013). Milligan et al. (2013) stated, "Even lurkers can learn effectively in connectivist environments: taking the knowledge they acquire to their own external networks" (p. 156).

The guiding principles for an open, social, connected course, according to Couros (2009), are that instructors assume the role of facilitators and social connectors rather than that of lecturers or knowledge delivery systems. Learners in these courses engage in social knowledge creation and participate in collaborative activities. In addition, learners should be provided assignment choices to allow for alignment between an individual's personal and/or professional goals and course outcomes. It is expected that connections developed between learners and course facilitators across social networks should outlive the course. These connections between learner and MOOC facilitators/other learners that last beyond the course provide a sense of ongoing support to learners as they begin implementing what they have learned during the MOOC.

Learners can leverage emerging technology tools to consume and create content and reflections on personal learning experiences that can be shared across distributed networks using Twitter, LinkedIn, blogs, and other social media tools. Online synchronous events draw a community of learners together and help grow MOOCs because community members typically invite their colleagues, friends, and classmates to join the event and thus expand the community. Adams et al. (2014) confirmed Cormier's notion of MOOCs being event-based learning experiences, much like attending a sporting event, and that it is this "eventedness" that contributes to their uniqueness.

7. ROLE OF THE INSTRUCTOR

The instructor as facilitator role includes curating content for the learners, aggregating ideas to help clarify discussions, modeling expected interaction patterns, being visibly present, and amplifying important ideas and concepts (Rodriguez, 2013). This role is quite different from that of the traditional lecturer and requires a considerable shift in pedagogy and practice. Rather than controlling a classroom, an educator now influences or shapes the network; in other words, control has been replaced by influence (Dunaway, 2011).

Sam Brenton, one of the 2013 HumanMOOC facilitators, stated:

> Social learning is the missing ingredient in too many MOOCs. I was so interested to teach The Human Element because it explored ways in which to embed that crucial peer-peer learning in a large scale (if not quite massive) online course, but also because it offered an opportunity to practice those techniques and embody the approach it was trying to promote. I was pleased to discover just how straightforward it was to stimulate and guide quite rich learning conversations among large numbers of people. True, this audience of learners was prepared to participate (as social participation was essentially the subject of the course) but nevertheless I took away a renewed conviction that it is absolutely possible to create rich learning dialogues within the environment of a large online open course. My two takeaway lessons: 1) that you need well designed learning activities to prompt social learning, aligned with the outcomes and embedded in the assessment regime; 2) perhaps a less fashionable point of view but not to be overlooked – that the software's UI is vital if you want to make it easy for social learning to flourish; simple below-the-line comment tools won't work well for true dialogue, and the over-engineered forums of the recent past are likely to be too complex for many learners. So: learning design and user interface design are essential.

Much like the work of Ke (2010), the HumanMOOC instructors made use of instructor self-disclosure coupled with feedback on students' discussion board posts to strengthen the sense of connection and motivate students. The presence of the facilitators and participants throughout the course and across various social media networks enhanced the sense of community (Kilgore and Lowenthal, 2014; Kop, 2011). There is a significant body of research that notes student-to-student interactions of a high-quality nature lead to student success, and instructor presence can be reduced if social presence of the students is increased (Anderson, 2003; Brinthaupt et al., 2011). In the HumanMOOC we noted that the participants were very active socially. Our goal was to ensure that this MOOC exploited network learning principles to create "highly motivated, personally relevant, and socially situated learning" at scale (Macleod et al., 2014, p. 246).

8. REDESIGNING BASED ON THE LEARNING AND REFLECTIVE PROCESS

After teaching HumanMOOC in 2013, receiving feedback, and reviewing learner reflections and evaluations, a new design team was formed. This time the team included two learners from the previous course iteration. The new team made use of several processes during the redesign phase: live coediting, resource curating, and sharing, expert consultations, and collaborative content creation. The new version of the course was presented as a more reflective design as it was based on data and experiences of both instructors and learners.

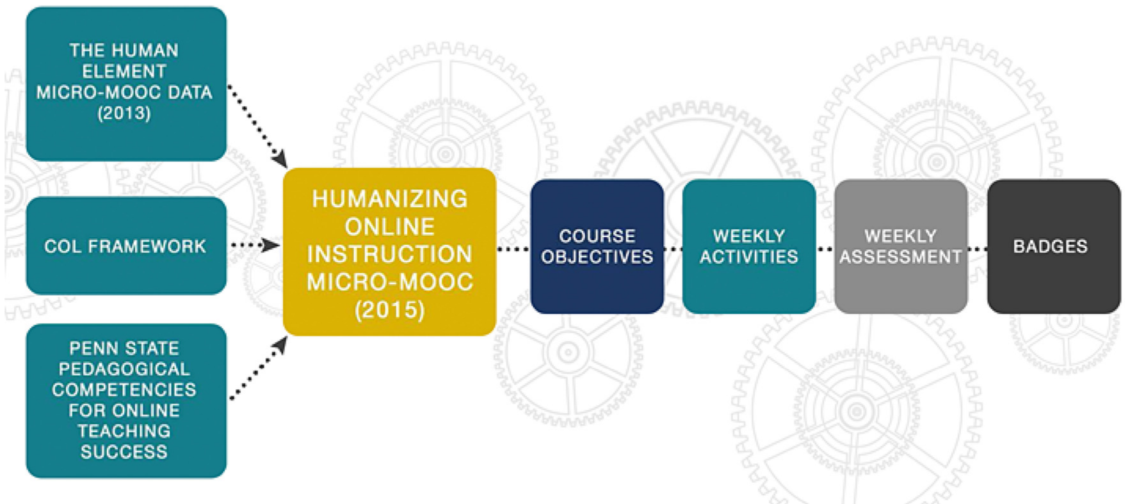

FIG. 2: The considerations for a new HumanMOOC design

9. SECOND ITERATION: THE HUMANMOOC 2015

Humanizing Online Instruction: Building a Community of Inquiry was the second offering of the HumanMOOC 2013 and was designed to prepare online instructors who teach college and university courses to improve learning and teaching practices in their online courses. Each of the weekly modules contained annotated research related to social, instructor, and cognitive presence elements of the CoI framework (Garrison et al., 2000) grounding the application-based activities in theory. Each week of the MOOC was designed as a stand-alone module in which participants could earn individual badges for completing specific tasks for that week, or elect to complete all assignments and earn a completion badge. However, assignment submission was voluntary and participation was still encouraged even if participants did not wish to complete assignments or earn badges.

Engagement in this networked community of practice was designed to stimulate the process of inquiry and collaboration among educators. Participants explored emerging technologies (e.g., flipgrid and voicethread) and created digital assets that they could employ in their own instruction. Several “live” events also took place during this course.

10. EXPERIMENTS (IF ANY) WITH INNOVATION

One of the design principles of the HumanMOOC was not only to describe innovative ways in which instructors could enhance their online teaching practices, but to actually model these techniques for participants as they completed the different learning activities within the MOOC. Videos were used in innovative ways in the HumanMOOC that encouraged active participation and reflective learning. For instance, during the first week of the course, participants were asked to introduce themselves via video rather than text as a means to increase social and peer presence among participants and develop a sense of community and connectedness early on in the course. Furthermore, participants were asked to create flipgrid videos to reflect on how they plan on increasing instructor presence in their online courses. Having participants engage in these activities over multiple assignments increased their confidence by allowing them to practice the skills necessary for effective video creation and integration in a safe place while receiving constructive feedback from MOOC facilitators and other participants.

One HumanMOOC participant, Helen DeWaard, shared her experience in a blogpost:

> "I'm a reluctant video star. I'm sure I'm not the only one. Once we face the camera for the first time, our uncertainties arise. My comfort with my video voice has increased with exposure and experience due to some #HumanMOOC work. The first task for this open, online course was to create a video introduction. The second task had each participant creating a video to introduce their online course to their students. Then more video capture using Flipgrid where our face and voice was recorded while answering some focus questions. After each of these experiences, and with encouragement and feedback from the course instructors and participants, I became less reluctant to face the camera."

This participant goes on to share how she was able to incorporate what was learned in her own teaching practice, "With culminating projects for my own course to mark, I decided to do a video for each of the students to provide feedback on their digital stories. I sat facing the camera, notepad with jot notes at my side, green screen behind me, and I recorded a message to each of my 34 students. At the end of this process I felt that I had shared a personal message and connected in a small way to each of my students."

11. UTILITY OF INNOVATION FOR ONLINE EDUCATION

The stages of adoption (SA) of technology instrument is a single item survey that measures educators stage of technology adoption and includes six stages: (i) awareness, (ii) learning the process, (iii) understanding the application of the process, (iv) familiarity and confidence, (v) adaptation to other contexts, and (vi) creative applications to new contexts. Because the purpose of HumanMOOC was to help educators utilize audio and video recording technologies and social media to increase their presence in online instruction, it was used in this pilot study as a pre- and posttest to allow us to measure the effectiveness of the MOOC by testing whether their level of technology adoption changed as a result of participating in the HumanMOOC. Furthermore, due to the complexity and novelty of learning in MOOCs compared to formal online classes, many researchers argue that terms such as learning and achievement should not be assessed in the conventional sense (i.e., final grades or completion) (Ho et al., 2014). Thus, using this scale can give us a sense of participants' learning gain and achievement as change in their level of technology adoption in their online courses.

A gain score was calculated for each participant. In this case a negative gain score means that there has been an increase in their level of adoption of audio/video recording and social media tools while a positive score means a decrease in their level of adoption. The average increase in participants' adoption of audio and video recording tools was .82 (i.e., the average increase for audio/video recording tools increased by approximately one level on the SA scale) while their level of adoption only increased by .06 for social media tools. This is due partly to the fact that the educators who completed the course were very connected via social media. The increase in the adoption of video for online teaching is worth noting as it may mean that they will develop more video for their own courses in the future. Interviews with participants in the future will help shed some light on the impact that this course had on their teaching practices.

12. PROSPECTS FOR THE INNOVATION

The apparent shortcomings of traditional professional development coupled with the current proliferation of MOOCs for learning and training have shaped new visions of teacher learning and professional development (Stevens, 2013). These new practices include the adoption of networking technologies in supporting teacher professional development. While advanced online technologies are gradually decreasing the barriers of traditional professional development programs, instructional designers are still faced with the challenge of designing online venues for professional development that are based on sound design principles and also take advantage of the strengths of the online medium. In this paper, we share our experience designing an MOOC for online faculty and designers that combines the principles of social constructivism and communities of practice (CoPs).

There is a significant opportunity to continue to provide professional development to educators in order to help transform pedagogy and practices as new technologies continue to allow us to explore new pedagogical innovations. Without these design-based research experiences it will be difficult to explore and share these innovations at scale and across institutions, which is why using MOOCs to scale these innovations is key to their success. If teaching and learning centers at universities leveraged MOOCs to deliver innovative professional development, thus expanding the pool of options for educators, this course significantly impacts the profession.

REFERENCES

Adams, C., Yin, Y., Madriz, L., and Mullen, C., A Phenomenology of Learning at Large: The Tutorial Sphere of xMOOC Video Lectures, *Distance Educ.*, vol. **35**, no. 2, pp. 202–216, 2014.

Anderson, T., Getting the Mix Right Again: An Updated and Theoretical Rationale for Interaction, *Int. Rev. Res. Open Distance Learning*, vol. **4**, no. 2, 2003. Accessed on June 14, 2016.

Bates, T., Comparing xMOOCs and cMOOCs: Philosophy and practice. [Web log message], http://www.tonybates.ca/2014/10/13/comparing-xmoocs-and-cmoocs-philosophy-and-practice/; Accessed on October 13, 2014.

Brinthaupt, T.M., Fisher, L.S., Gardner, J.G., Raffo, D.M., and Woodard, J.B., What the Best Online Teachers Should Do. http://jolt.merlot.org/vol7no4/brinthaupt_1211.htm, *J. Online Learning Teaching*, vol. **7**, no. 4, pp. 515–524, 2011.

Couros, A., Open, Connected, Social—Implications for Educational Design, *Campus-Wide Info. Syst.*, vol. **26**, no. 3. 232–239, 2009.

Cormier, D., Rhizomatic Education: Community as Curriculum, *Innovate J. Online Educ.*, vol. **4**, no. 5, 2008.

Crosslin, M. and Dellinger, J., Lessons Learned While Designing and Implementing a Multiple Pathways xMOOC + cMOOC, http://www.editlib.org/p/149999, Slykhuis, D. and Marks, G. (eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2015*, Association for the Advancement of Computing in Education, Chesapeake, VA, pp. 250–255, 2015.

deWaard, I., Abajian, S., Gallagher, M., Hogue, R., Keskin, N., Koutropoulos, A., and Rodriguez, O., Using mlearning and MOOCs to Understand Chaos, Emergence, and Complexity in Education, http://www.irrodl.org/index.php/irrodl/article/view/1046/2026, *Int. Rev. Res. Open Distance Learning*, vol. **12**, no. 7, 94–115, 2011.

Dunaway, M.K., Connectivism: Learning Theory and Pedagogical Practice for Networked Information Landscapes, *Ref. Serv. Rev.*, vol. **39**, no. 4, 675–685, 2011.

Fazackerley, A., UK Universities Are Wary of Getting on Board the MOOC Train, http://www.theguardian.com/education/2012/dec/03/massive-online-open-courses-universities, *Guardian*, 2012.

Garrison, D.R., Anderson, T., and Archer, W., Critical Inquiry in a Text-Based Environment: Computer Conferencing in Higher Education, *Internet Higher Educ.*, vol. **2**, no. 2-3, pp. 87–105, 2000.

Ho, A.D., Reich, J., Nesterko, S.O., Seaton, D.T., Mullaney, T., Waldo, J., and Chuang, I., HarvardX and MITx: The First Year of Open Online Courses, (HarvardX and MITx Working Paper No. 1), 2014, http://ssrn.com/abstract=2381263; Accessed on February 1, 2016.

Ke, F., Examining Online Teaching, Cognitive, and Social Presence for Adult Students, *Comput. Educ.*, vol. **55**, no. 2, pp. 808–820, 2010.

Kilgore, W. and Lowenthal, P.R., The Human Element MOOC: An Experiment in Social Presence, Wright, R. D. (ed.), *Student-Teacher Interaction in Online Learning Environments*, IGI Global, Hershey, PA, pp. 373–391, 2014.

Koller, D., Ng, D., Do, C., and Chen, Z., Retention and Intention in Massive Open Online Courses: In Depth, http://www.educause.edu/ero/article/retention-and-intention-massive-open-online-courses-depth-0, *Educause Rev.*, pp. 1–33; June 3, 2013.

Kop, R., The Challenges to Connectivist learning on Open Online Networks: Learning Experiences during a Massive Open Online Course. *Int. Rev. Res. Open Distance Learning*, vol. **12**, no. 3, pp. 19 –38, 2011.

Kop, R., Fournier, H., and Mak, J., A Pedagogy of Abundance or a Pedagogy to Support Human Beings? Participant Support on Massive Open Online Courses, *Int. Rev. Res. Open Distance Learning*, vol. **12**, no. 7, pp. 74–93, 2011.

Macleod, H., Haywood, J., Woodgate, A, and Sinclair, C., Designing for the Unknown Learner, *Proceedings of EMOOCs 2014 European MOOC Stakeholders Summit, Experience Track*, pp. 245–248, 2014.

Milligan, C., Littlejohn A., and Margaryan, A., Patterns of Engagement in Connectivist MOOCs. *MERLOT J. Online Learning Teaching*, vol. **9**, no. 2, pp. 149–159, 2013.

Moran, M., Seaman, J., and Tinti-Kane, H., Teaching, Learning, and Sharing: How Today's Higher Education Faculty Use Social Media, Babson Survey Research Group, Boston, MA, 2011.

Roebuck, D., Siha, S., Bell, R.L., Faculty Usage of Social Media and Mobile Devices: Analysis of Advantages and Concerns, *Interdisciplinary J. E-Learning Learning Objects*, vol. **9**, pp. 171–192, 2013.

Rodriguez, O., The Concept of Openness Behind c and x-MOOCs (Massive Open Online Courses), *Open Praxis*, vol. **5**, no. 1, pp. 67–73, 2013.

Siemens, G., Connectivism: A Learning Theory for the Digital Age, [Web log message], http://www.elearnspace.org/Articles/connectivism.htm; Accessed on December 12, 2004.

Stevens, V., What's with the MOOCs, *TESL-EJ*, vol. **16**, no. 4, pp. 1–14, 2013.

Stewart, B., Massiveness + Openness = New Literacies of Participation? *MERLOT J. Online Learning Teaching*, vol. **9**, no. 2, pp. 228–238, 2013.

Tan, E. and Pearce, N., Open Education Videos in the Classroom: Exploring the Opportunities and Barriers to the Use of YouTube in Teaching Introductory Sociology, *Res. Learning Technol.*, vol. **19**, 2012.

Wenger E., *Communities of Practice. Learning, Meaning and Identity*, Cambridge University Press, Cambridge, UK, 1998.

Wenger, E., McDermott, R.A., and Snyder, W., *Cultivating Communities of Practice: A Guide to Managing Knowledge*, Harvard Business Press, Boston, MA, 2002.

Williams, R., Karousou, R., and Mackness, J., Emergent Learning and Learning Ecologies in Web 2.0, Special Issue – Connectivism: Design and Delivery of Social Networked Learning, *Int. Rev. Res. Open Distributed Learning*, vol. **12**, no. 3, pp. 39–59, 2011.

Zahn, C., Krauskopf, K., Kiener, J., and Hesse, F., Designing Video for Massive Open Online Education: Conceptual Challenges from a Learner-Centered Perspective, *Proceedings of European MOOC Stakeholder's Summit*, Lausanne, Switzerland. P.A.U., pp. 160–167, 2014, http://www.researchgate.net/profile/Anja_Lorenz/publication/263543544_Open_Online_Courses_in_the_conte◎t_of_higher_education_an_e◎aluation_of_a_◎ er◎ an_cMOOC/lin◎s/54941c560cf2e1b6095f97bc.pdf#page=5;◎Accessed◎on◎ebruar◎◎1◎2016.

FROM "MY WORK" TO "OUR WORK": A RETURN TO THE MISSION OF HIGHER EDUCATION

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Abstract

In the rapidly changing and complex global lives and careers our students confront, the mission of higher education should be to focus on higher order learning. E-portfolios allow for the portability of learning across institutions, time and place; the centrality of student ownership and co-creation of their learning; the flexibility and inclusiveness of the panoply of learning in all its manifestations and guises; and the equity e-portfolios bring to the learning process when all students can see themselves and their accomplishments in a framework of educational attainment. Innovation in technology now allows higher education to integrate the teaching and learning process into something greater than its constituent pieces; something with meaning beyond the moment in which it occurs. Digital learning, and in particular, e-portfolios have the potential to create the ability to engage students in liberal education - intentional, integrative, creative, indeed entrepreneurial student-authored/faculty guided and mentored education we must have to honor our higher education mission and to prepare a democratic society where all of our people can flourish.

KEY WORDS: eportfolio, prior learning, meaning-making, rubrics

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1. INTRODUCTION

In the rapidly changing and complex global lives and careers our students confront, the mission of higher education should be to focus on higher-order learning. The environments of learning for students have changed, now often including a blend of face-to-face and synchronous or asynchronous digital interactive space. The "traditional" student, ages 18–22, fresh out of high school, is joined now by students who have already gained learning from significant work experience as well as from online resources from organizations such as Coursera, Saylor, and Udacity. At the same time, higher education knows much more now than in the past about how students learn and how faculty effectiveness through engaging with students to advance learning can be achieved and enhanced. Innovation in technology now allows higher education to integrate the teaching and learning process into something greater than its constituent pieces, something with meaning beyond the moment in which it occurs.

2. OVERARCHING CHALLENGE CONFRONTING HIGHER EDUCATION—THE MY VERSUS OUR CONCEPT

Employers have been telling higher education for years what they expect and need from the graduates of higher education. Employers obviously want individuals well prepared to perform a set of functions central to whatever the specific job requires, e.g., accounting, teaching, art curation, etc. However, more important to today's employers is the need for these same people to be well prepared with such skills and knowledge as problem solving in diverse settings, knowledge and understanding of democratic institutions, values and judgment essential for contributing to the community and society, oral and written communication, teamwork skills in diverse groups, and critical thinking and analysis (HRA/AACU, 2015a). Yet, students believe that they are much better prepared as graduates to function in these capacities and for career success than employers report from their own hires (HRA/AACU, 2015b). This disconnect between employer expectations and student perceptions is troubling to say the least. What messages are we giving our students? What evidence do we have on actual proficiency on these sets of skills and abilities?

Further illustrating the importance of this disconnect in perceptions regarding the preparation of students in higher education is a recent report from Levy and Murnane (June 1, 2013).The changing nature of jobs in the twenty-first century economy mirrors a large shift in the nature of problems and opportunities confronting global communities. The authors track the trends in the changing work tasks required in the U.S. economy from 1960 to 2009. The clear trend is a consistent and noticeable decrease in jobs requiring manual tasks and routine cognitive tasks, and a large increase in jobs requiring working with new information and unstructured problems. In other words, knowledge of past and present is necessary but not for future success. The ability to transfer knowledge and experience and to integrate disparate learning sources into new situations and unscripted problems is increasingly essential for today's graduates.

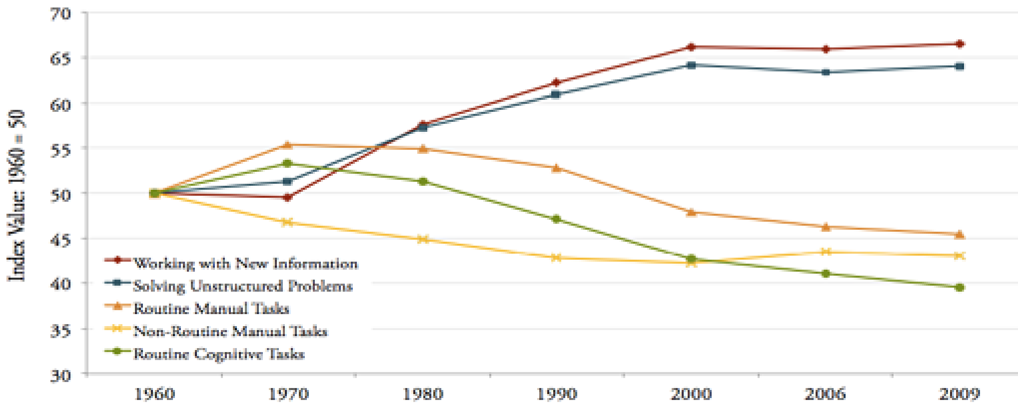

FIG. 1: Index of changing work tasks in the U.S. economy 1960-2009.

Not only has the work world been changing, the entire foundation of higher education also has been shifting during the latter twentieth century and continues in the present. There was a time when higher education and its faculty were the keepers and shepherds of knowledge; individuals came to the academy to learn and to engage with other knowledgeable colleagues. Now knowledge and access to it are ubiquitous and readily available instantaneously from virtually anywhere in the world. If anything, we have a surfeit of knowledge; we are overwhelmed with information access and variety. As a result, the roles of faculty and higher education also need to shift. Rather than persisting in the knowledge dissemination mode, the more important role has become to engage and help our students develop the capacities to understand and discover information that is reputable and based on solid research and evidence, to identify appropriate sources, to ask critical questions, to examine different perspectives, and to engage repeatedly and systematically in posing, exploring, and solving complex, often unscripted problems and questions, both enduring and contemporary. In essence, the role of higher education is to challenge our students and to guide them in the sense making and meaning making of the knowledge they bring with them and the knowledge they acquire through their education.

The nature of the changes occurring in the world, the economy, and the academy illustrate that those in higher education no longer can meet the needs of students through individualized courses or chunks of information. The magnitude and qualitative expectations for higher-order learning argue forcefully for the higher educational enterprise to reenvision itself in its collective responsibility for achieving the outcomes necessary for enabling student success. The work of the academy is now a shared set of activities that requires greater integration and intentionality than in the past, greater collaboration across traditional silos and boundaries, and a clearer recognition that we can achieve more working together openly than we can individually behind closed doors.

3. A ROLE FOR TECHNOLOGY IN FACILITATING MEANING MAKING IN HIGHER EDUCATION

In practice, we need to provide our students with the ability to examine their own learning and to describe or represent that learning to others, to be able to demonstrate their abilities to integrate their learning, to locate appropriate and useful information, to communicate to various audiences in intelligible ways, to organize and apply learning to new situations and issues.

Just as technology, through the Internet and telecommunications, has been an instrumental force enabling the push toward deconstruction and atomization of higher education learning, it also has the means to help students and institutions make much better sense and meaning out of the educational experiences of our students. Specifically, students on more than half of campuses across the United States report the use of student e-portfolios (Dahlstrom and Bichsel, 2014). E-portfolio technology has continued over the years to become more sophisticated and less expensive and more user friendly. E-portfolios have spawned an entire community of practices, providing support, resources, scholarship, and functions that helped spread the usefulness of a technology that is flexible and malleable for students seeking a higher education[1].

Part of the success of e-portfolios lies in the fact that portfolios are familiar to many parts of the academy, e.g., architecture, education, art, writing. They have also, although in a rather different context, been used for decades by institutions working with returning students on valuing prior learning. The advances in technology have now allowed students and institutions to include in portfolios learning captured through oral presentations, performances, community projects, visual displays, web pages, videos, etc. E-portfolios are a tool that reflects and encompasses the multitude of ways we learn and express our learning that in prior years could only be appreciated in person.

A key component of e-portfolios, though, is that they are most useful when they are conceived as more than a file drawer of collected artifacts or demonstrations. As the e-portfolio approach to learning and teaching has grown, the potential of the approach for learning has developed frameworks and design principles to guide good practice. Both commercial and noncommercial e-portfolio platforms and software now have incorporated into their organization frameworks the capacity to allow users to engage in three key activities for enhanced student learning, namely, inquiry, reflection, and integration (LAGCC, 2014), across their coursework, the curriculum, cocurricular and lived experiences, across areas of study, and among and between different institutions and educational providers.

Institutions have also been exploring innovative ways to integrate e-portfolios into other important functions within higher education. A common aspect of e-portfolios is a resume, i.e., a connection between what was learned through the student's education and subsequent employment or graduate pursuits upon graduation. Career centers have begun to connect the digital revolution in connecting employers with graduates to specific examples from e-portfolios illustrating what students have actually done through their educational careers to develop proficiency in the skills and abilities required for a position. Other institutions have begun to connect student e-portfolios with the formal transcript, again recognizing the decreasing confidence in what the transcript presents in relation to the actual level of proficiency students have in practice.

Employers have indicated that they are interested in seeing examples of what students have actually done—the project report, the presentation of findings to the board, the design for a public service announcement, the packaging designed for a product, or a webpage for a specific purpose. "In addition to a resume or college transcript, more than four in five employers say an electronic portfolio would be useful to them in ensuring that job applicants have the knowledge and skills they need to succeed in their company or organization" (AACU/HRA, 2013). The e-portfolio is a precursor to what might be called a "flipped transcript," i.e., a way to let each student lead with the presentation of their educated self through a demonstration of what learning outcomes, skills, and abilities of a liberal education they have developed and at what levels of proficiency that prepare them for success. This flipped transcript presentation of examples, illustrations, and actual work from the student could then be linked to the courses and activities that constituted the student's educational preparation. This concept would place the student and her learning at the forefront rather than the institutional formalism, while still preserving the institution's imprimatur that the work was the student's and was recognized by the institution.

4. ESTABLISHING EVIDENCE AND EXPECTATIONS FOR QUALITY LEARNING

One of the primary roles of faculty and institutions of higher education is to certify that student learning meets standards of achievement associated with the appropriate level of degree or credential being granted. At institutions of higher education, the governing documents typically vest the awarding of degrees and credentials in the faculty. Therefore, even in the current digital world and changing roles outlined above, the faculty and the judgment of faculty still reside at the center of most credential granting processes. Albeit, pressures are increasing to provide badges and like credentials through industry groups, more focused, narrowly defined groups of experts, and even through crowdsourcing. The two common threads in this argument are that those who know the area of learning and its attendant skills and abilities in practice should be the ones exercising judgment about the quality of the learning, and that there is broad agreement about what an acceptable level of proficiency looks like.

One of the few methods for assessing student learning that exists in higher education today that enjoys widespread use by faculty and institutions, that meets the calls for broad expert participation in defining the quality measures, and that was developed by the experts is the VALUE (Valid Assessment of Learning in Undergraduate Education) rubrics (Rhodes, 2010; Sullivan, 2015). The VALUE rubrics were developed by teams of interdisciplinary faculty and other educational professionals from across the sectors of higher education in the United States. The rubrics address 16 essential learning outcomes associated with what employers say they are looking for in graduates and what faculty say they are trying to teach. Based on rubric downloads and queries, the rubrics are being explored and utilized on thousands of campuses in the United States and around the world.

Every rubric represents the results of research on the key dimensions or criteria of learning identified by faculty and experts for the respective outcomes that are associated with developing proficiency in each outcome. Each criterion in each outcome is further articulated through a performance descriptor that describes what learning would look like when examining a piece of student work. Emphasis in the performance descriptors is on using verbs reflective of levels of increasing complexity and sophistication of learning, i.e., higher-order thinking and learning as a student progresses from beginner to more masterful quality learning.

There are several examples of multiple institutions using the same VALUE rubrics to bring learning expectations into closer alignment across institutions where student transfer is frequent and critical for student progress and success, especially for returning and working adults. The American Council of Research Librarians conducted a study across multiple institutions around measuring information literacy learning as they considered performance expectations for student learning related to the ACRL standards. The South Metropolitan Higher Education Consortium (SMHEC) brought 12 of their members together, public and private, two- and four-year colleges and universities, to use the VALUE written communication rubric to engage in conversations about first year writing expectations since so many of their students took classes among the member institutions. By using the rubric, the faculty began to share a common language. "Faculty learned the importance of relying on common reference points to support scoring versus relying on personal experience and preferences. Through all of this, they recognize, discuss, and to some extent eliminate the inconsistencies in expectations and standards for 1st year writing" (SMHEC, 2014). Several two- and four-year transfer partners utilized VALUE rubrics to address student transfer success between their institutions by examining assignments and expected levels of learning to better prepare students for academic progress.

Currently, the VALUE rubrics are a centerpiece of the Multi-State Collaborative for Learning Outcomes Assessment (MSC)[2], co-led by the Association of American Colleges and Universities and the State Higher Education Executive Officers' (SHEEO) association. Twelve state higher education executive agencies are collaborating along with approximately 100 two- and four-year campuses in their respective states (plus several private four-year liberal arts colleges in a related project) to collect samples of student work and to have it scored by a group of faculty and staff who have gone through calibration training on three of the VALUE rubrics, namely, written communication, critical thinking, and quantitative literacy. The project is designed to both see if the VALUE rubric approach can be scaled to a nationwide level and to begin to identify what benchmarks for learning in these three areas of learning look like, i.e., a landscape of learning across a wide variety of campuses across the United States. An emphasis of the VALUE/MSC project is to establish the reliability and validity of the VALUE rubric approach to measuring student learning[3].

5. COMMITTING TO "OUR WORK"

Fortunately for the faculty and the students (re-)entering higher education now, higher education has been developing tools, frameworks, and mind-sets that allow more students to see themselves as part of the academy, to be able to bring their previous learning and experiences to their educational goal attainment in ways they count and adds to their progress, and to focus not only on knowledge acquisition, but also on application and use of knowledge, and integration of learning in multiple contexts.

E-portfolios are both the most pervasive, developed digital approach/medium we now have at higher education institutions for student demonstration of learning and they provide the means to meet the need for ongoing development and evolution of technology's potential to shape and to enhance ways our students interact with each other, with faculty and staff, and with the world, and how each of these influence their own individual and communal selves and identities.

E-portfolios are particularly powerful when conceived as spaces for reflective practice for meaning making in the following ways:

- The integration of knowledge and its use or application.
- The development of self through social interaction with others and to engender, a sense of agency and control over one's life.
- The creation and recognition of the whole student person and the value of seeing self and other students within a set of interacting forces in their lives, as more than discrete data elements.

E-portfolios are a high-impact practice just as assessment can be a high-impact practice—when done well. One of the powerful things about e-portfolios is the transparency and visibility they provide for learning attainment. E-portfolios allow for the portability of learning across institutions, time, and place, the centrality of student ownership and co-creation of their learning, the flexibility and inclusiveness of the panoply of learning in all its manifestations and guises, and the equity e-portfolios bring to the learning process when all students can see themselves and their accomplishments in a framework of educational attainment.

In short, digital learning, in particular e-portfolios, has the potential now to create the ability to engage students in the liberal education—intentional, integrative, creative, indeed entrepreneurial student-authored/faculty-guided and mentored education—we must have to honor our higher education mission and to prepare a democratic society where all of our people can flourish.

REFERENCES

AACU/HRA, *It Takes More than a Major: Employer Priorities for College Learning and Student Success*, Association of American Colleges and Universities and Hart Research Associates, Washington, DC, p. 3, 2013.

Boessen, G., South Metropolitan Higher Education Consortium, Chicago Heights, IL, http://www.southmetroed.org/programs/writing-initiatives, Accessed on June 14, 2016.

Dahlstrom, E. and Bichsel, J., ECAR Study of Undergraduate Students and Information Technology, Research Report, ECAR, Louisville, CO, October, 2014, http://www.educause.edu/ecar, Accessed on October 19, 2014.

HRA/AACU, *Falling Short: College Learning and Career Success*, Hart Research Associates and Association of American Colleges and Universities, Washington, DC, 2015a.

HRA/AACU, *Optimistic About the Future, But How Well Prepared? College Students' Views on College Learning and Career Success*, Hart Research Associates and Association of American Colleges and Universities, Washington, DC, 2015b.

LAGCC, Catalyst for Learning Initiative, LaGuardia Community College, New York City, 2014, http://c2l.mcnrc.org/framework, Accessed on June 14, 2016.

Levy, F. and Murnane, R.J., Dancing with Robots: Human Skills for Computerized Work, Third Way NEXT, http://content.thirdway.org/publications/714/Dancing-With-Robots.pdf, Accessed on June 14, 2016.

Rhodes, T. (ed.), *Assessing Outcomes and Improving Achievement: Tips and Tools for Using Rubrics*, Association of American Colleges and Universities, Washington, DC, 2010.

Sullivan, D., The VALUE Breakthrough: Getting the Assessment of Student Learning Right, Association of American Colleges and Universities, Washington, DC, 2015, http://aacu.org/value, Accessed on June 14, 2016.

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[1]See for example, the International Journal of ePortfolios, http://theijep.com; the Inter/National Coalition for Electronic Portfolio Research, http://ncepr.org/; Association for Authentic, Experiential and Evidence-Based Learning; http://www.aaeebl.org; Electronic Portfolio Action and Communication (EPAC), http://epac.pbworks.com; and the Association of American Colleges and Universities, http://www.aacu.org/eportfolios.

[2]This project is supported by a grant from the Bill and Melinda Gates Foundation.

[3]See the Association of American Colleges and Universities, http://www.aacu.org/value/msc; State Higher Education Executive Officers, http://www.sheeo.org/msc.

A METHOD FOR ASSESSING EXPERIENTIAL LEARNING FOR EPORTFOLIOS

Bill Heinrich

Jeno Rivera

Abstract

This article focuses on how to assess reflective artifacts in ePortfolios from multiple perspectives for holistic and authentic learning and career development. We specifically identify the video-selfie, a series of short testimonials captured on video, as an artifact type because the assessor can observe multiple dimensions of learning likely to occur in an experiential learning process and important to integrated learning. The ePortfolio is a strong tool with the ability to capture and help students authentically describe rich, experiential, and high-impact learning gains across topics and environments. Using video reflections as an artifact in ePortfolios helps both learners and facilitators identify, document, and gain insight on cognitive, affective, and behavioral outcomes.

KEY WORDS: experiential learning, assessment, immersive

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Jeno Rivera is a lifelong learner immersed in the educational field originally as a K-12 educator, secondary teacher educator, community educator, and most recently as an administrator in a self-directed learning program. Jeno gets geeked out observing her students discovering a love for learning. @jenorivera

1. INTRODUCTION

This paper focuses on how to assess reflective artifacts in ePortfolios from multiple perspectives for holistic and authentic learning and career development. We specifically identify the video selfie, a series of short testimonials captured on video, as an artifact type because the assessor can observe multiple dimensions of learning likely to occur in an experiential learning process and important to integrated learning. The ePortfolio is a strong tool with the ability to capture and help students authentically describe rich, experiential, and high-impact learning gains across topics and environments (Batson, 2015). Using video reflections as an artifact in ePortfolios helps both learners and facilitators identify, document, and gain insight on cognitive, affective, and behavioral outcomes (Lambert, 2013; McKillop, 2007; Robin, 2009; Tao et al., 2013).

Well-designed uses of reflection in experiences are highly important to individual and group learning gains and are linked to the promotion of postgraduate career decision making (Brown, 2004), college and career success (Niehaus and Inkelas, 2015), holistic learning (Kolb and Kolb, 2005), critical thinking outcomes (Heinrich et al., 2015), and ethical development (Goralnik et al., 2012). Higher education practices include widespread implementation of learning outcomes and connections across disciplines through reflection (Kolb, 1984; Eyler and Giles, 1999; Jones and Abes, 2004; Kiely, 2005). Cross-discipline connections bring learners closer to achieving institution-level integrated learning outcomes. These outcomes are often embedded in experiences with characteristics of high-impact educational practices (Kuh and Schneider, 2008).

The iterative nature of high-impact environments and reflective practice leads to students' prior, diverse experiences surfacing throughout learning activity (Brown, 2004). Awareness of prior learning allows students to acquire new perspectives and build on prior experiences and, in turn, discover new interests (Niehaus and Inkelas, 2015). This research addresses a specific gap in directly assessing individual learning in high-impact practices in higher education. Additionally, this method allows users to model learning expectations by linking assessment of both intended and embedded outcomes—those that are likely present, but unassessed.

2. HIGH-IMPACT AND EXPERIENTIAL LEARNING ASSESSMENT

2.1 A METHOD TO ASSESS INTENDED AND EMBEDDED LEARNING OUTCOMES

High-impact and experiential learning assessment (HELA) describes a process to identify and assess learning outcomes that are embedded, but not specifically intended by program leaders. Learner reflections are the primary source of identifying and evaluating embedded learning outcomes. Embedded outcomes are known to exist as a by-product of high-impact educational practices (Kuh and Schneider, 2008). These outcomes generally fall in the range of transferable or boundary-spanning knowledge, skills, and abilities including, but not limited to, communication, affective awareness, identity development, or socioemotional growth. Outcomes intended in one experience may well be embedded in another.

2.2 PATH AND PROCESS

Our process varied based on the concrete experiences of the students and the approach of the program leader, but relied on reflective learning processes captured by media artifacts in addition to traditional writing assignments. Assessments were planned to complement one another by identifying both intended and embedded outcomes. Partnerships between assessment providers and program leaders were foundational to the process.

The key personnel involved included the program leader, the assessment provider, and the learners. In our method, the term program leader referred to the individual or team that designed and/or delivered an educational experience for the purposes of some intended learning outcomes. Program leaders assessed the experience for intended outcomes such as a disciplinary lesson or leadership development, career awareness, or community engagement. The term assessment providers referred to the researcher, assessment team, or program evaluator who partnered with the program leaders planning to implement an experiential learning cycle. In all of our cases, the assessment providers were the research team responsible for identifying embedded outcomes.

The program leader and assessors performed a joint critical examination of the design to identify concrete experiences, reflective opportunity, sense making, and/or application (Kolb, 1984). The goal of the partnership was to gain clarity about the experience design, program leader, assessment provider, and learner expectations. The order of learning activity influenced outcomes —but just as importantly, the reflection process responded and aligned to the relative length and depth of the experiences.

Next, a shared assessment plan for intended and embedded learning outcomes was developed. Because program leaders and assessors intentionally approached learning from different avenues, assessors worked with our partners to clarify the assessment method for intended outcomes. Embedded outcomes were considered ahead of the course, but not planned for in assessment design, so anticipating outcomes during planning phases was helpful to streamline the actual assessment process later on. Both parties identified and preselected rubrics for embedded outcomes that were important to the student, program, and/or institution. Assessors found that using three rubrics that spanned learning domains (cognitive, affective, behavioral) was useful to identify diverse outcomes embedded in the experience.

Video self-reflections were used by learners to capture a series of reflective statements (four to five reflections over the duration of the experience). Reflections provided assessors an opportunity to identify multiple learning outcomes. The seriated format allowed learners to demonstrate changes without having to analyze or make conjectures about the reasons for the change in thinking, as in a summative artifact. In some cases, program leaders provided prompts that were not structured to create an intended outcome, but rather to solicit embedded outcomes. Assessors observed that a loosely structured prompt worked well to encourage learners to explore integration among previous and current experiences. Additionally, when prompts provided some parameters for learners, the individuals avoided filming a rambling video self-reflection.

File transfer, security, and logistics were addressed in planning phases, but continued to evolve given field placements. Consideration of bandwidth and upload time, file sharing between learners and multiple assessors, and public or private settings all improved the efficiency of the experience for both learners and assessors. While some ePortfolio and assignment platforms were optimized for video sharing and feedback, effective communication with learners about expectations for file formats ahead of the experience saved time during the assessment phase.

Once all the videos were transferred to a storage location for analysis, the main task was to format the videos for coding. One path that we utilized was to transcribe the videos; however, we observed some loss of emotional and affective qualities that occurred when viewing the videos. Another mode we utilized as an alternative to transcribing was uploading the videos into a coding software system that allowed segment coding of videos. This approach required specific software, faster upload/download speeds, and storage space. Assessors found that it was a more time consuming to code specific sections of the videos as compared to solely coding text.

Rubrics used as a coding tool increased the efficiency and reliability of the assessment process. Assessors worked together to code all artifacts focused on intercoder agreement through discussion of the presence or absence of a code. For each learning experience, a single codebook, including rubrics, was created for ongoing communication and feedback with program leaders and learners. Program leaders used additional perspectives on their content to reflect on the experience.

A feedback report to the learner provided individuals the opportunity to receive and integrate feedback from multiple perspectives to gain lessons from the high-impact practice and insight into their learning plans and career paths. Reporting and feedback was situated as a conversation, with time and space for both instructors and learners to consider the implications of comments, data, and and possible pathways. Reports included both an itemized list of outcomes achieved and a weighted visual reports indicating the relative concentration of outcomes in the context of the experience.

3. RECOMMENDATIONS FOR IDENTIFYING EMBEDDED OUTCOMES IN ePortfolio ASSESSMENT

3.1 CULTIVATE HIGH-QUALITY ARTIFACTS

The presence of existing high-impact educational practices in a learning ecology is necessary to assessing outcomes. One of the main goals for the program leader is to support the learners in creating video artifacts to capture and document high-impact learning experiences. In our experience, when program leaders provided guidance through prompts or assignment objectives, learners better documented learning outcomes as compared to documenting with no parameters. Additionally, assessors observed that if learners were given a time parameter for each video artifact, it forced the learners to be succinct in their reflection. Time constraints tended to eliminate nonsequential rambling that may occur with an unlimited time frame. Finally, with today's advances in technology, program leaders do not need to provide learners special equipment to create videos. High-quality videos can be created on most portable electronic devices (e.g., phones, cameras, tablets) that students possess. It is notable, however, that students in our studies were most comfortable using their own devices. Technical challenges such as lost audio occurred when students used equipment mandated by program leaders.

3.2 USE RUBRICS TO AID ASSESSMENT

Using multiple rubrics to assess high-impact and experiential learning designs resulted in the identification of multiple learning domain outcomes. This was a major advantage of the HELA method. The perspective shift from a single learning outcome framework to multiple or boundary-spanning outcomes provided through multiple rubrics was passed on to learners through reporting and ePortfolios.

From a technical reporting standpoint, the use of some ePortfolio platforms or learning management systems may greatly aid in tagging video segments to rubric dimensions. Advances in video Web applications (i.e., YouTube, Vimeo) to allow content tagging for individual segments (coding instances) could help an assessor streamline the rubric coding process. By creating tags that align to rubric dimensions/levels, an assessor simply creates a codebook to apply to a video upload. Managing data this way can alleviate the need for more expensive qualitative coding software.

3.3 COACH LEARNERS TO APPLY LEARNING

Learning outcomes emerging from high-impact experiences and intended and embedded learning processes provided a compelling narrative of disciplinary content and boundary-crossing communication skills. Translational scholarship, a form of storytelling about academic work, is a strong opportunity for learners to synthesize and integrate learning from multiple sources and experiences. The nature of the outcomes identified through this method may help a student select an appropriate audience for their story. Alternatively, the act of reflection can become the focus of a story.

3.4 MAKE LEARNING VISIBLE

Individuals engaging in the HELA method can more easily amplify their individual brand in terms of desired values or trajectory. With advances in educational technologies, learners have an opportunity to share their learning outside of academe through badges and by creating an individual profile. Software badging platforms (Credly, Mozilla Open Badge, or Educate Empower) can amplify data and feedback for additional audiences. Further, these platforms have the capability to link to professional branding sites, such as LinkedIn, Wordpress, or Digication. Linking learning data to social media outlets could be a valuable asset for learners who are looking to broadcast non-credit-bearing achievements to specific audiences.

4. CONCLUSION

Learning through reflection in the context of ePortfolios creates space for learners to assemble and build on previous experiences, potentially deepening each subsequent reflective artifact. Instructors can take advantage of such opportunity by encouraging learners to review previous reflections prior to recording new reflective statements. The HELA method for assessing embedded learning contributes to learner and program gains by leveraging the depth and breadth of existing powerful learning experiences. HELA provides a feedback loop to both the learner and the program leader about the nature of embedded outcomes, otherwise unassessed. With multiple communication outlets available, learners can broadcast the value of their experiences to many audiences in customized ways. Through a rigorous application of this assessment method, learners are able to use data and feedback to inform next steps on a lifelong learning journey.

REFERENCES

Batson, T.B., Toward "The Field Guide to ePortfolio," June 10, 2015; http://www.aaeebl.org/blogpost/1008436/Batson-Blog of Batson Blog.

Brown, S.C., Where This Path May Lead: Understanding Career Decision-Making for Postcollege Life, *J. College Student Dev.*, vol. **45**, no. 4, pp. 375–390, 2004.

Eyler, J. and Giles, D.E, *Where's the Learning in Service-Learning?* Jossey-Bass, San Francisco, 1999.

Goralnik, L., Millenbah, K.F., Nelson, M.P., and Thorp, L., An Environmental Pedagogy of Care: Emotion, Relationships, and Experience in Higher Education Ethics Learning, *J. Exp. Educ.*, vol. **35**, no. 3, pp. 412–428, 2012.

Heinrich, W., Habron, G., Johnson, H., and Goralnik, L., Critical Thinking Assessment across Four Sustainability-Related Experiential Learning Settings, *J. Exp. Educ.*, vol. **38**, no. 3, pp. 1–21, 2015.

Jones, S.R. and Abes, E.S., Enduring Influences of Service Learning on College Students' Identity Development, *J. College Student Dev.*, vol. **45**, 2, pp. 149–165, 2004.

Kiely, R.A., Transformative Learning Model for Service-Learning: A Longitudinal Case Study, *Michigan J. Community Service Learning*, vol. **12**, no. 1, pp. 5–22, 2005.

Kolb, D.A., *Experiential Learning: Experience as the Source of Learning and Development*, Prentice-Hall, Englewood Cliffs, 1984.

Kolb, A.Y. and Kolb, D.A., Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education, *Acad. Man. Learning Educ.*, vol. **4**, no. 2, pp. 193–212, 2005.

Kuh, G.D. and Schneider, C.G., *High-Impact Educational Practices: What They Are, Who Has Access to Them, and Why They Matter*, AAC&U, Washington, DC, 2008.

Lambert, J., *Digital Storytelling: Capturing Lives, Creating Community*, Routledge, New York, 2013.

McKillop, C., Imagining Assessment in Higher Education through On-Line Storytelling and Visual Expressions of Learning, *2nd Annual Research Symposium on Imaginative Education*, Vancouver, July, 2007.

Niehaus, E. and Inkelas, K.K., Exploring the Role of Alternative Break Programs in Students' Career Development, *J. Student Affairs Res. Practice*, vol. **52**, no. 2, pp. 134–148, 2015.

Robin, B.R., Digital Storytelling: A Powerful Technology Tool for the 21st Century Classroom, *Theory into Practice*, vol. **47**, no. 3, pp. 220–228, 2009.

Tao, X., Niu, Q., and Jackson, M., Using an Ethnographic Approach to Collect Emotional Data in Affective Learning Research, *Int. J. Info. Electron. Eng.*, vol. **3**, no. 2, pp. 216–220, 2013.

PORTFOLIO ASSESSMENT BRIDGES THE EMPLOYMENT GAP FOR HEALTH CARE: CERTIFIED WORKERS SAVE TIME AND MONEY, MEET THE INDUSTRY'S GROWING NEED FOR QUALIFIED WORKERS

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Abstract

Today's increasing number of aging baby-boomers has many implications for society, but perhaps the greatest is the impact they will have on the healthcare industry. The first of the boomers turned 65 in 2010, and the U.S. Census Bureau estimates that the nation's population over the age of 62 will increase from about 46 million now to about 83 million by 2030. As the boomers reach retirement age they will place an increasing strain on the shrinking pool of allied health care professionals - those who have specialized training, but are not doctors or nurses. According to the Bureau of Labor Statistics, more than 6.1 million health care workers will be needed nationally between 2008 and 2018 to fill new jobs and replace workers who leave their jobs or retire. At the same time, this growing segment of the population will require quality medical care more than ever. All of this comes together to create a severe shortage of skilled labor in the healthcare industry just when more seniors than ever will need care. Prior Learning Assessment (PLA) can help address this shortage by documenting the relevant skills and knowledge workers may already have from their work and life experiences, and how they can translate those skills into college credit so that these workers can more quickly earn the credentials they need to fill positions left vacant by the boomers.

KEY WORDS: Portfolio Assessment

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1. INTRODUCTION

Today's increasing number of aging baby boomers has many implications for society, but perhaps the greatest is the impact they will have on the health-care industry. The first of the boomers turned 65 in 2010, and the U.S. Census Bureau estimates that the nation's population over the age of 62 will increase from about 46 million now to about 83 million by 2030. As the boomers reach retirement age, they will place an increasing strain on the shrinking pool of allied health-care professionals, i.e., those who have specialized training, but are not doctors or nurses. According to the Bureau of Labor Statistics, more than 6.1 million health-care workers will be needed nationally between 2008 and 2018 to fill new jobs and replace workers who leave their jobs or retire.

At the same time, this growing segment of the population will require quality medical care more than ever. All of this comes together to create a severe shortage of skilled labor in the health-care industry just when more seniors than ever will need care.

Prior learning assessment (PLA) can help address this shortage by documenting the relevant skills and knowledge workers may already have from their work and life experiences, and how they can translate those skills into college credit so that these workers can more quickly earn the credentials they need to fill positions left vacant by the boomers.

2. OVERVIEW OF HEALTH-CARE INDUSTRY WORKFORCE

According to *A Universal Truth: No Health Without a Workforce*, prepared by the World Health Organization, the world is short 7.2 million health-care workers, and that figure will grow to 12.9 million by 2035. The report blames the problem on an aging health-care workforce combined with staff retiring or leaving the profession.

At the same time, here in the United States, through the Affordable Care Act, more Americans than ever have access to health-care coverage. And as baby-boomers age, they will likely be experiencing more health issues, which translates into a need for more medical assistants, physical therapists, health information technicians, health-care managers, dental hygienists, paramedics, and pharmacy technicians—all jobs that require either at least an associate degree or program certificate.

There are nondegreed health-care workers with knowledge and skills that may be at the college level. These workers may be great candidates to move up within an organization but may lack the degrees necessary for promotion. Perhaps they earned a phlebotomy certificate and then worked successfully as a phlebotomist for several years, perhaps they did volunteer work heading up community blood drives or have been patient advocates at a hospital, all roles that do not require college degrees.

These workers may have knowledge and skills gained from their experiences that can be evaluated for college credit. If workers have the opportunity to have their skills evaluated for college credit, it will help them more quickly and affordably earn college degrees and certificates. For example, perhaps they bring knowledge and experiences that match what they would have learned had they completed classes such as Patient Care Skills, Foundations of Patient Examinations, or Principles of Administrative Management, which are typically offered in colleges offering a degree in Allied Health professions.

PLA is a promising solution that is helping more people, and especially adults, complete their bachelor's degree and earn professional credentials. In addition, the Council for Adult and Experiential Learning (CAEL) conducted a study on PLA and adult student outcomes that examined data on 62,475 adult students at 48 colleges and universities across the country. CAEL found that graduation rates are 2.5 times higher for students with PLA credit, and found that PLA students also had higher persistence rates and a faster time to degree completion.

There are many methods of PLA, including standardized exams (like College-Level Examination Program tests, also known as CLEP tests) and previously evaluated corporate or military training (evaluated by organizations like the American Council on Education or the National College Credit Recommendation Service). The PLA method that holds significant promise to assist health-care workers is portfolio assessment, where workers document their skills in a portfolio that includes a written narrative along with other forms of proof of their learning. The portfolio assessment process benefits both the employer and the worker—the employer has access to a wider, richer labor pool, and the worker benefits by earning credits faster and at a fraction of the cost. The key, however, is for qualified faculty portfolio assessors to carefully evaluate the demonstrated learning and skills the candidate brings to the process to ensure credit awarded is meaningful and marketable.

Every college has policies in place to allow students to earn a certain amount of credit through prior learning assessment methods, including prior learning assessment portfolios. However, because many institutions have their own individualized portfolio assessment program, there is no consistency across higher education. In addition, only students attending a college with a portfolio assessment program in place could earn credits using this method.

To help ensure access to portfolio assessment for all students, and to offer a consistent and rigorous process, CAEL created the LearningCounts portfolio assessment program. LearningCounts is a way to make portfolio assessment an option to all appropriate students enrolled at an institution, and even those not yet enrolled.

With LearningCounts, adults can use the knowledge they gained from life, work, and military experience to prepare a portfolio to be evaluated for a possible college credit recommendation at a fraction of the cost and time required to earn conventional classroom credits. Adults can choose from an instructor-led or do-it-yourself online portfolio development course where they learn to identify and demonstrate college-level learning gained outside of the classroom. During the portfolio development course, the instructors guide students through the process of building a learning portfolio that aligns their knowledge to a college course from a regionally accredited college or university. As part of their portfolio, students write a narrative that addresses the learning outcomes of the course for which they are requesting credit. Students also include relevant documentation that helps to demonstrate their expertise. As part of the course, the instructor shares the portfolio grading rubric that assessors will be using to evaluate the student's portfolio.

Once a student submits his or her portfolio for assessment, a LearningCounts faculty assessor with appropriate subject matter expertise evaluates the student portfolio. If the student receives a credit recommendation for their portfolio, they can order a transcript and have it sent to the registrar at their college or university.

LearningCounts student Jill Powell started off her professional career as an EKG technician and a certified nurse's aide before opening a small business with her husband in 2002. After the economic recession forced them to close their business in 2010, Jill became interested in pursuing a bachelor's degree to better her job prospects.

Already possessing an associate degree in science along with other educational certification, Jill had been searching for educational programs that would allow her to receive course credit for skills already learned.

“I stumbled onto LearningCounts, and I’m so glad that I did,” she says.

As part of LearningCounts, Jill enrolled in the instructor-led course teaching her how to develop a portfolio that demonstrated skills learned outside of a classroom. She then built portfolios requesting credit for two courses, namely, Introduction to Electrocardiography and Medical Technology for Health Care Professionals.

A LearningCounts faculty member assessed Jill’s portfolios and determined that she had demonstrated the learning skills necessary to receive credit for the two medical courses. Including the credits Jill earned for the LearningCounts instructor-led portfolio development course, as well as for passing a CLEP test, she earned a total of 15 prior learning assessment credits. In December 2011, she received her bachelor’s degree.

For Jill, the opportunity to save time accumulating college credit for skills already learned was a major selling point of LearningCounts. “[The] instructor was fabulous; he was always available by e-mail. It was just a wonderful, wonderful experience.”

Rolondo Russell, Program Director at Ultimate Medical Academy, is a subject matter expert in the field of health-care administration and serves as a faculty assessor for LearningCounts. With a bachelor’s in health administration, an MBA in health-care management, and over 23 years in the field, Rolondo says that a key component for the LearningCounts assessor is the ability to review a narrative from a student who wants credit for what they have done in the past, or curriculum they think they already know, and objectively evaluate whether the student not only understands the knowledge or skills but can apply it.

As part of the process, the LearningCounts assessor evaluates how well the portfolio meets the requirements provided by CAEL as follows:

- Has the student been able to demonstrate a clear distinction between theory and practice through the written narrative?
- Has the student shown the ability to use and learn from his or her past experiences related to the course outcomes and apply it?
- Has the student provided supporting documentation to justify knowledge, understanding, and application of the objectives?

As part of the initial training to become a faculty assessor, Rolondo received hands-on coaching by working through an actual assessment with the director of assessment at LearningCounts. In addition to training on the technology, he was trained on assessment processes and policies and discussed best practices related to evaluating student portfolios. He reviewed portfolios that were approved along with ones that were not, so he could see for himself what the key components were.

He also says one of the most important aspects of his job is evaluating the documentation. “The narrative in the portfolio is a great way for the student to tell his or her story, but you can’t just fall for the story. You need to look at the documentation and the end product to make sure the student truly can apply the knowledge. For example, just because an applicant learned something 20 years ago doesn’t necessarily mean he or she actually remembers it enough to apply it today. At the end of the day, I say to the student, 'If you've done this, let me see that you've learned it and applied it.'"

3. CONCLUSION

As the number of older Americans continues to rise, they will increasingly be leaving the health-care workforce and requiring more medical care, which will place an enormous burden on the nation's health-care delivery system. As a result, the demand for workers will continue to grow. Innovative tools like LearningCounts portfolio assessment can help nondegreed health-care workers earn credits more quickly and more affordably. Getting skilled workers credentialed more quickly can help to ensure we all have access to the health care we will need in the future.

RESEARCHING DECLARATIVE, PROCEDURAL, AND META-COGNITIVE KNOWLEDGE THROUGH ACTIVE LEARNING IN DISASTER-THEMED 3D VIRTUAL WORLDS

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Abstract

This paper summarizes an educational researcher's approach to determining the impact of active learning in disaster-themed 3D virtual worlds. The goal of the project is to advance students' declarative, procedural, and meta-cognitive knowledge by implementing measurable robot-mediated interaction activities in 3D virtual worlds. Through the design and iterative development of unique active learning activities for authentic international collaboration, the participants are able to synergize engineering and science academic content with the learning processes. In addition, by actively participating in international 3D virtual tele-collaboration challenges, which include controlling basic robots within a simulated disaster zone, quantitative metrics of students' programming skills and psychometric assessment of declarative, procedural, and meta-cognitive knowledge can be measured. This will enable educators to quantify the impact of active learning.

KEY WORDS: virtual worlds, knowledge, education

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1. INTRODUCTION

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Anderson et al. (2001), developing the work of Bloom (1956), proposed a hierarchy of knowledge consisting of factual knowledge (relating to a specific discipline), declarative knowledge (relationship between concepts so that constituent parts can function as a whole), procedural knowledge (techniques and procedures and when to use), and meta-cognitive knowledge (knowledge of demands, strategies and one's limitations). Learning science researchers have suggested though that an assessment-focused culture still prevalent in twenty-first century education negatively impacts on learners' capabilities to progress from static declarative knowledge to active procedural knowledge and, subsequently, to meta-cognitive knowledge (Bachnik, 2003; Towndrow and Vallance, 2013). Moreover, Hase (2011, p. 2) states, "The acquisition of knowledge and skills does not necessarily constitute learning. The latter occurs when the learner connects the knowledge or skill to previous experience, integrates it fully in terms of value, and is able to actively use it in meaningful and even novel ways."

A possible solution to this current circumstance worth researching is to engage high school and undergraduate students by their actively participating in international collaborative tasks that integrate the design, construction, and programming of robots in both the real world and a novel, unique virtual world simulation. The theoretical foundations of collaboration lie in social constructivism where personal meaning-making is constructed with others in a social space. Collaboration can promote creativity, critical thinking, and dialogue, and assist with deeper levels of knowledge generation, promote initiative, and when conducted internationally, address issues of culture (Vallance and Naamani, 2013). One outcome is the development of an essential twenty-first century skill that Jukes et al. (2010, p. 66) term collaboration fluency: "Collaboration fluency is teamworking proficiency that has reached the unconscious ability to work cooperatively with virtual and real partners in an online environment to create original digital products."

Through collaborative efforts, it is speculated that students will be incentivized to use knowledge gained in theoretical technology courses to pragmatically solve challenges of increasing task complexity (Barker and Ansorge, 2002; Vallance and Martin, 2012; Vallance et al., 2013). To confirm this requires researchers to specifically measure students' development of declarative (recall), procedural (apply and analyze), and meta-cognitive (understand) knowledge (Anderson et al., 2001; Schank, 2013). This can be undertaken by triangulating data of task complexity, pre- and post-task surveys, and analysis of digitally captured communication (Vallance et al., 2015).

2. JUSTIFICATION OF 3D VIRTUAL WORLD SIMULATIONS AND ROBOT-MEDIATED INTERACTIONS

Learning is considered to be a process whereby knowledge is created through the transformation of experience (Kolb, 1984). In earlier iterations of this research, reported in Vallance and Martin (2012), deFreitas and Neumann (2009) suggest that the appeal, immersivity, and immediacy of virtual worlds can support this experiential learning, but education requires a reconsideration of how, what, when, and where we learn. deFreitas and Neumann use Dewey's concept of inquiry to posit that learners' virtual experiences, their use of multiple media, the transactions and activities between peers, and the facilitation of learner control between them will lead to transactional learning, which "aims to support deeper reflection upon the practices of learning and teaching" (deFreitas and Neumann, 2009, p. 346), which arguably leads to "wider opportunities for experiential learning" (deFreitas and Neumann, 2009, p. 346).

An approach then is required that encourages exploration; development of procedural knowledge; iterative, recursive, and logical thinking; structured task breakdown; and dealing with abstraction—in other words, computational thinking (Wing, 2006). An instructivist pedagogy does not support such an approach, so an alternative has to be sought. Prior successful projects have involved simulation and robotics. For instance, beginner programming concepts can be introduced and experienced using the graphical LEGO Mindstorms software, which has been shown to support programming through its semiotic drag-and-drop graphical user interface (Lui et al., 2010).

Previous research has also determined that closed and highly defined tasks provide the necessary comparability and empirical data to determine the success of task completion (Vallance and Martin, 2012). To satisfy these criteria, the programming of a robot to navigate mazes of measurable complexity can be adopted (Olsen and Goodrich, 2009). Research can be designed to observe students communicating in a 3D virtual world when they are programming a robot to follow distinct challenges that, in turn, results in tangible and quantifiably measured outcomes.

Consequently, LEGO Mindstorms robots hardware and software are used in this research as tools to mediate the communication of the students. The research has been designed to collate data of students collaborating in 3D virtual worlds to program LEGO robots to successfully navigate mazes from start to completion in both the physical world and simultaneously within the 3D virtual spaces. This is implemented online by students remotely located in Japan and UK who: (i) design circuits that necessitate the use of robot maneuvers and sensors and (ii) collaborate in a virtual world to solve predetermined tasks. The task solutions necessitate the use of programming skills, collaboration, communication, and higher-level cognitive processes. It is posited that these experiences lead to personal strategies for teamwork, planning, organizing, applying, analyzing, creating, and reflection.

As LEGO EV3 robot programming components can be used to quantify task complexity and thus iteratively increase the challenges given to high school and undergraduate university students, a 3D virtual simulation provides interesting, engaging, and realistic yet safe contexts where robots are ordinarily utilized, e.g., disaster recovery situations. Virtual simulations allow remotely located students to enter as avatars to communicate and collaborate with other students. Data within world can also be captured for analysis. Through active participation in online, international, collaborative challenges it is anticipated that students will develop programming, design, and communication skills.

This section concludes with our research hypothesis: International collaboration in robot-mediated active learning interactions will significantly increase participants' declarative, procedural, and meta-cognitive knowledge.

3. METHODOLOGY

A quasi mixed-method design experiment is being implemented. For instance, a triangulated data set (problem and solution measures, cognitive process, specific knowledge) can be captured during implementation of tasks so that the researchers can determine the factors that impact the development of declarative, procedural, and meta-cognitive knowledge. The advantage of this method is that researchers can quantify students' experiences and correlate them with their task achievements. The methodology is summarized in Table 1.

TABLE 1: Methodology summary

Instrument	Metric
1. Task complexity (i.e., task problem and solution measures). Two dependent measures (task challenge and student skill) will be analyzed using a type-2, six-way mixed design ANOVA with the following independent variables: 1. Interaction modality (real, virtual) 2. Participant nationality (Japanese, UK) 3. Problem (demanding, manageable) 4. Solution (masterful, reasonable) 5. Task fidelity (<1,>1) 6. Task complexity (CTC, RTC) On finding any interaction effects, additional post hoc pairwise comparisons conducted using *t*-tests; SPSS software used	Task fidelity equals robot task complexity/circuit task complexity i.e., TF = RTC/CTC Circuit task complexity, CTC = $\sum N(d + m + o + s)$ where N_d = number of directions; N_m = number of maneuvers; N_o = number of obstacles; N_s = number of sensors Adapted from Olsen and Goodrich (2003) Robot task complexity, RTC = $\sum (Mv1 + Sv2 + SW + Lv3)$ where M = number of moves (direction and turn), S = number of sensors, SW = number of switches, L = number of loops; and where v = number of decisions required by user for each programmable block so that $v1 = 6$, $v2 = 5$, $v3 = 2$ Adapted from Vallance et al. (2013)
2. Analyze discourse of screen capture of all simulated tasks in the 3D virtual space and video capture of all real-world tasks. Discourse analysis of communication to identify evidence of cognition associated with remember, understand, apply, analyze, evaluate, create	Cognitive descriptors of remember, understand, apply, analyze, evaluate, create—as detailed in Anderson et al., 2002; Knipe and Lee, 2002; Martin and Vallance, 2008; and Vallance and Martin, 2012.

3. Analyze participants' experiences using pre-and post-task surveys.	Knowledge descriptors of declarative (recall), procedural (apply), and meta-cognitive (understand) knowledge, as detailed in Anderson et al., 2002.

The research to date has developed a metric termed task fidelity (Vallance et al., 2015). Task fidelity is defined as an indicator of the complexity of the circuit compared with the complexity of the program to complete the circuit. Although the development of task fidelity is beyond the scope of this paper (cf. Vallance et al., 2015), it has been determined that task fidelity is a useful indicator of the complexity of a task, and a cognitive determiner of task fidelity is immersion (or flow). To calculate immersion/flow, the Pearce et al. (2005) flow criteria of task challenge and skill have been used: "Amongst the various studies researching flow, an on-going issue has been to find a method for measuring flow independently from the positive states of consciousness (such as enjoyment, concentration, control, lack of self-consciousness, lack of distraction). One solution has been to use a measure of the balance between the challenge of an activity and the participant's perception of their skill to carry out that activity" (Pearce et al. (2005, p. 250). This has been further developed in this research using the eight-channel model of flow by Carli et al. (1998). A summary of flow data captured to date in this research is illustrated in Section V.

4. IMPLEMENTATION

4.1 FUKUSHIMA DISASTER-THEMED 3D VIRTUAL SPACE

Metaverse designers have created a virtual Fukushima nuclear plant using the Unity 3D application (see Fig. 1). The 3D space replicates the real-world Fukushima reactors with cooling towers prior to the disaster of March 2011. One of the technical challenges was to program a virtual robot to move within the Fukushima space and have its maneuvers replicated in the real-world lab by a LEGO Mindstorms robot. This has been achieved within an OpenSim virtual world (Arnold, 2012) but remains a challenge within Unity 3D at the time of publication of this paper. As the project matures, it is anticipated that students and adults gain hands-on experience moving around the simulated virtual Fukushima space and observing a physical robot simultaneously moving at a remote location (e.g., in a scaled mock-up of a hazardous building such as the reactor). It is anticipated that such user-accessible simulations with citizens controlling the virtual robot will create an awareness and understanding ofB disaster recovery, and not simply rely on retrospective information from unprepared experts (Guizzo, 2011). Consequently, as well as capturing data for analysis of cognitive processes, an affective aim is to familiarize students and the public with the complexities of nuclear power; given that there is much confusion about the situation at present in Japan (Vallance et al., 2013).

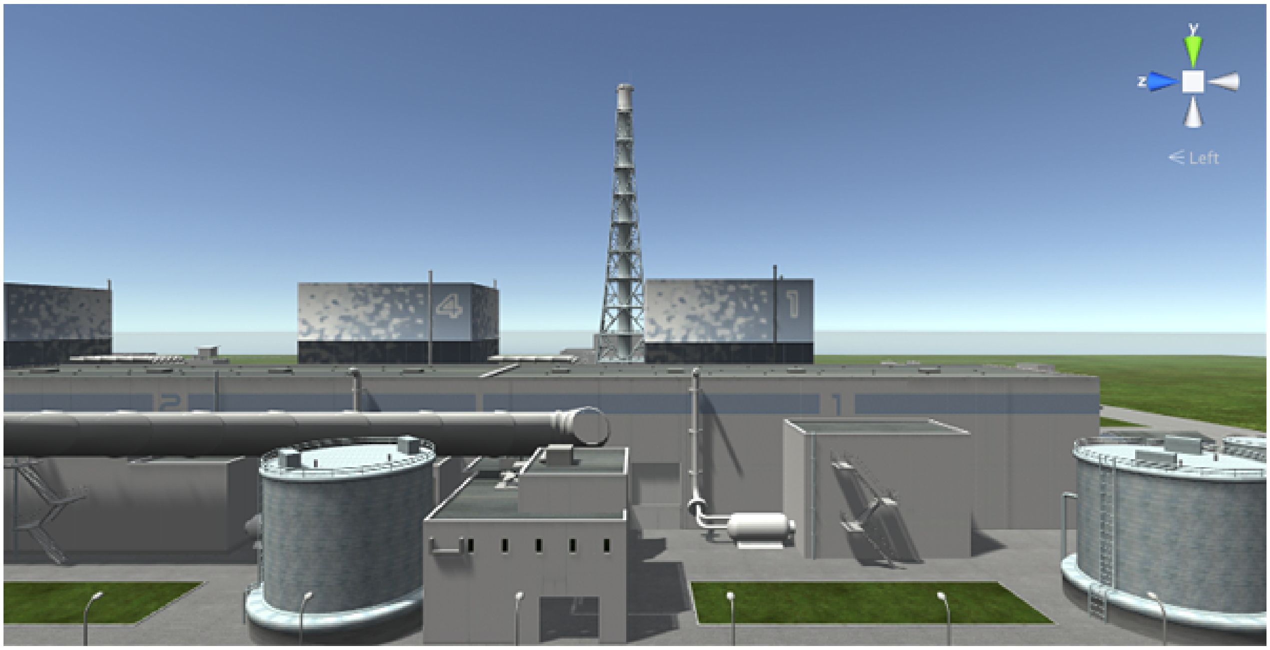

FIG. 1: Virtual Fukushima nuclear power plant

4.2 TRAINING AREA IN OPENSIM

Before entering the virtual Fukushima, students undertake tasks in the training area developed using OpenSim (see Fig. 2). The learner-centered design approach (cf. Vallance, 2012) enabled a number of innovative tools to be created and customized by the students in OpenSim, for instance, the ability to move a graphical representation of the LEGO robot object and leave a trace of the circuit in-world. Also, media objects in-world can display live streamed video from the lab in Japan (using the online Bambuser service) and also from an iPhone attached to the front of the LEGO robot using the Bambuser iPhone app. Virtual notice boards can be updated with text and images to aid communication. Additional interactivity has been added in the form of debris, which when touched by the virtual robot will explode. Although programming is mostly undertaken using the Mindstorms EV3 software, a LabView VI program has been developed to enable communication directly between an in-world prim and the physical LEGO robot (see Fig. 3).

FIG. 2: OpenSim training area

FIG. 3: Students remote control a LEGO EV3 robot to navigate a circuit

Some tasks to date have involved Japanese students collaborating with other remotely located Japanese students and some with Japanese students collaborating with UK students. Tasks have included maneuvering around obstacles using distance and turn commands, using touch sensors to navigate around obstacles, constructing a bridge and using touch sensors to move over obstacles, using light sensors to avoid obstacles, using sensors to locate items, and manipulating the tele-robotic controls to virtually maneuver our LEGO robot within the virtual space as part of "search and rescue" simulations. Communication between students has required the use of virtual world tools such as text panes, voice, live video streaming of respective real-world labs, and 3D presentation boards where Mindstorms program images were deposited. Avatars in-world enabled students to remotely maneuver a real-world robot in addition to a LEAP Motion controller set up for hands-free remote maneuvering of the EV3 robot. As previously reported by Vallance and Naamani (2013), "The developments have enabled students to actively engage in international collaboration, problem solving, construction of solutions, develop increasingly sophisticated communication and effective team working" (p. 63).

4.3 ROBOT-MEDIATED INTERACTIONS USING THE OCULUS RIFT.

To additionally engage the learners in the active design and construction of their learning environment both in the 3D space and the real world lab, a consultant Unity programmer was commissioned to initiate the design of an abandoned factory as the virtual space (see Fig. 4). The rationale is to combine a 3D simulation space for real-world collaboration; in this case, teaching the programming of robots contextualized by simulating a robot navigating within a restricted area. Student participants are presented with the following scenario:

> Four children have been admitted to hospital with apparent radiation sickness. They were playing in the old abandoned factory complex belonging to NEPCo (Nuclear Energy Production Company). Upon inspection, the factory area recorded a radiation value of 4.00 Sv/h. This measurement is the same value as the Fukushima Reactor 1. Note that a dose of 0.75 Sv/h can be enough to induce radiation sickness. Therefore, it seems it is too dangerous to enter the factory complex. It is estimated there are 5 radioactive bins within the complex. We are not sure where the radioactive bins are located and do not yet know why they have been dumped in the old factory complex. Your mission is to maneuver the robot and drone, locate the 5 radioactive bins, and return them to the designated safe area. Be careful! One wrong move can cause an explosion … and disaster!

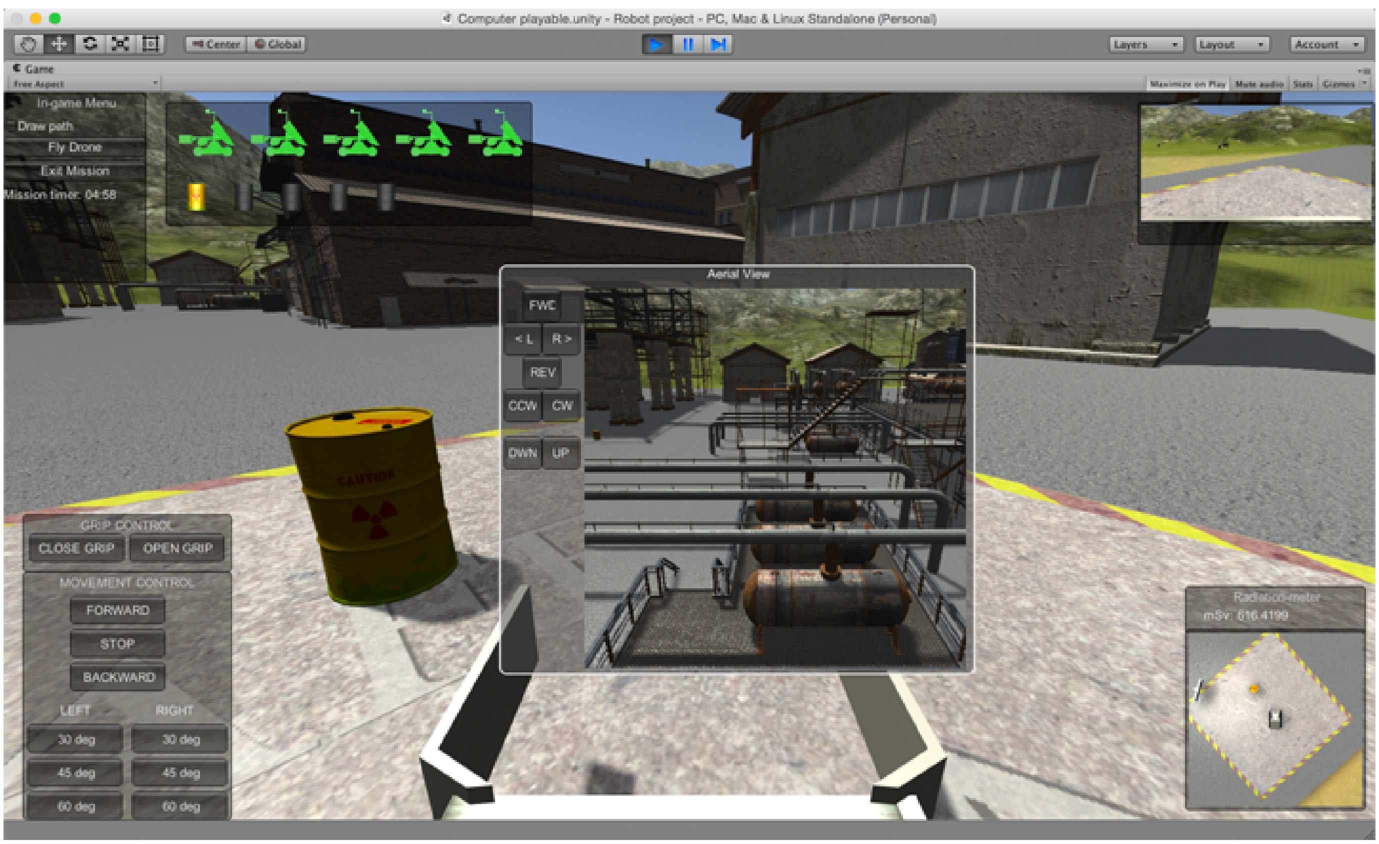

FIG. 4: Abandoned factory scenario

Students maneuver the virtual robot using the built-in controller to pick up radioactive bins (see Fig. 5). A radiation meter in the bottom right corner indicates radioactivity levels that provide a clue as to the nearness of the radioactive bins. A rearview mirror for the robot controller is viewed in the top right corner. A birds-eye view is offered via a virtual drone that can be maneuvered over the abandoned factory, seeking out the location of the radioactive bins. If the robot crashes, then the radioactive bins explode (see Fig. 6). On successful completion of the abandoned factory scenario, students are then teleported to the Fukushima nuclear power plant scenario

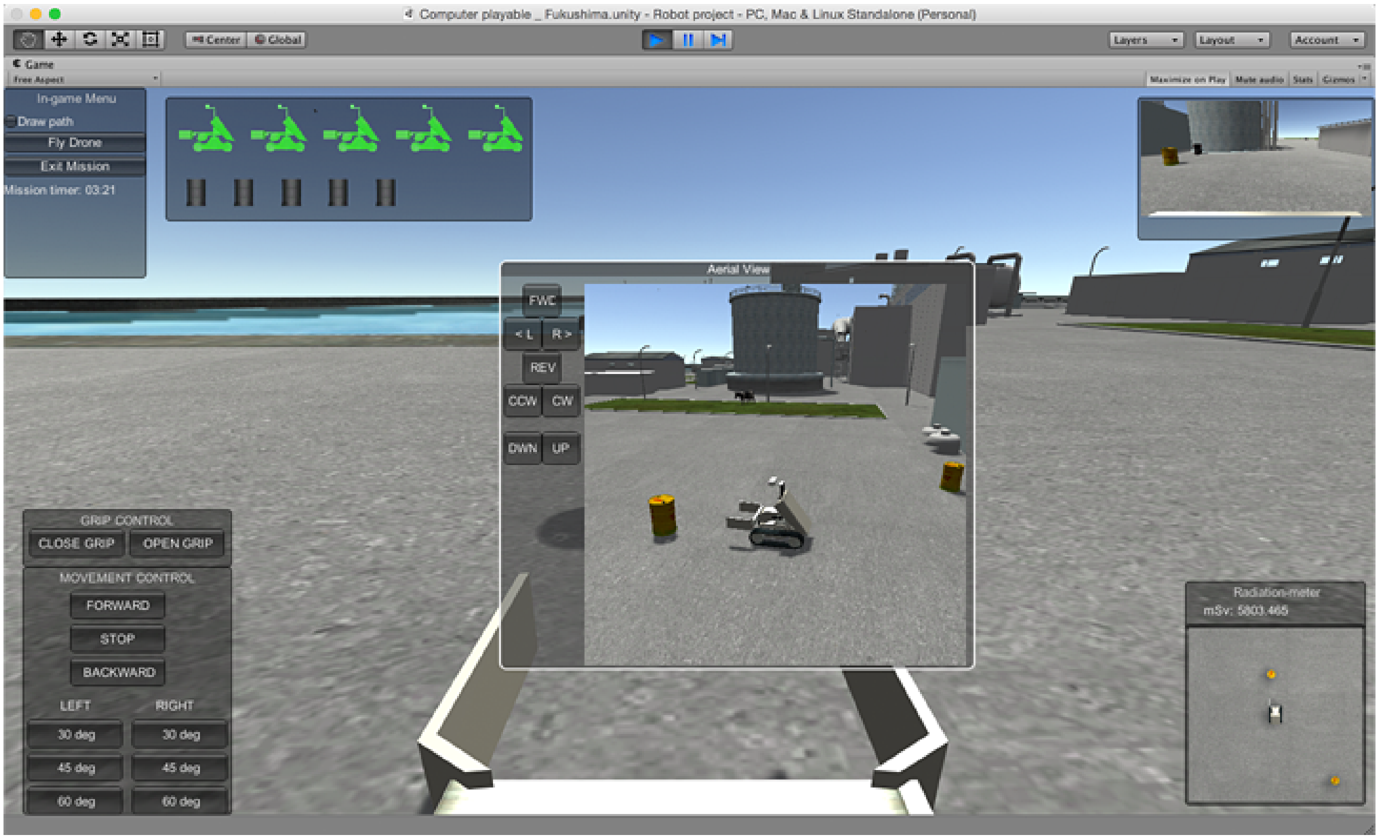

FIG. 5: Fukushima scenario

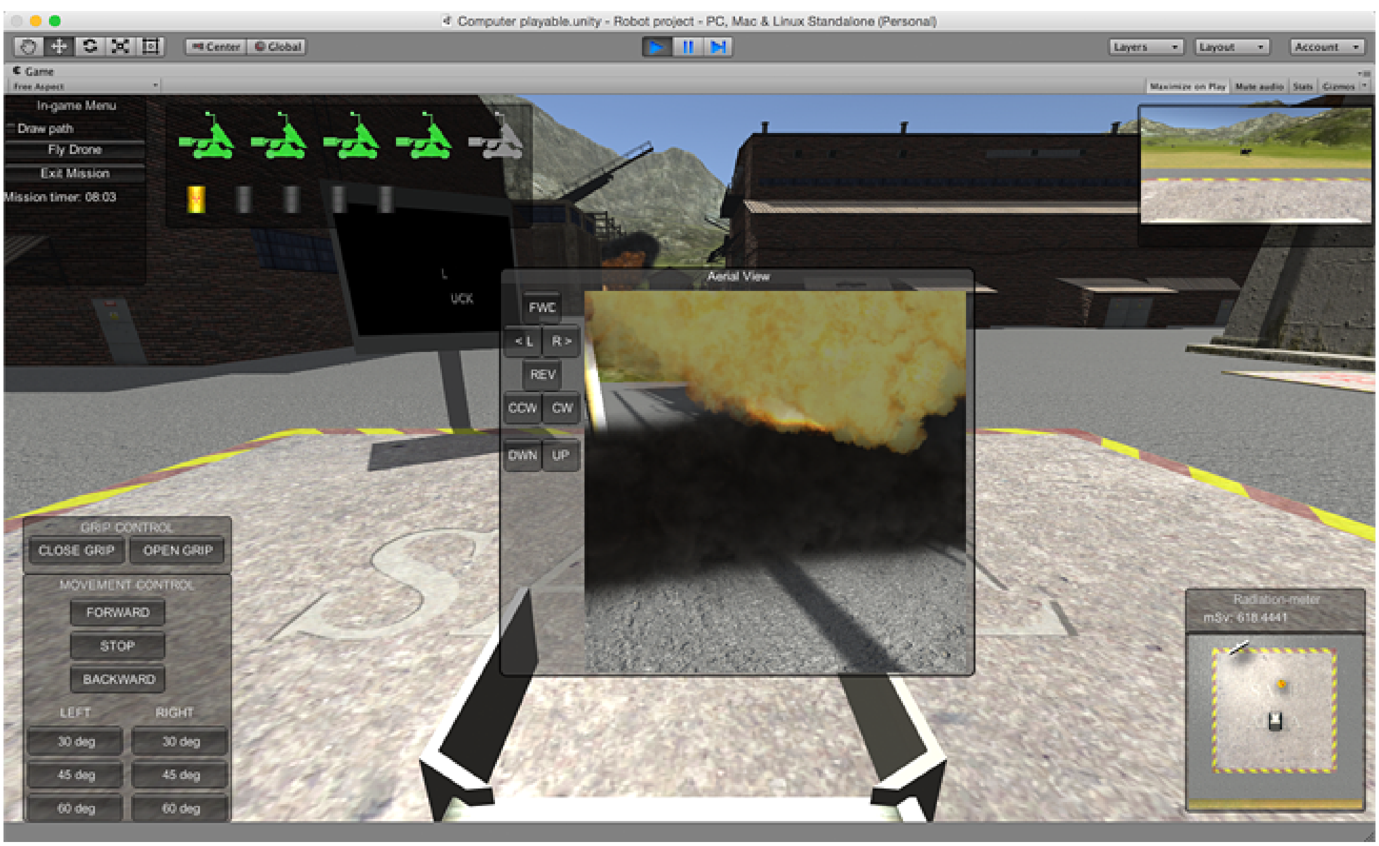

FIG. 6: Crashing the robot results in a disastrous explosion and the simulation is terminated

The project has also been developed to be viewable via the Oculus Rift 3D head-mounted display (see Fig. 7) and utilizes the hands-free Leap Motion controller. This research is in anticipation of commercial developments in virtual reality technologies that will enable users to log in to online 3D virtual spaces to engage and collaborate with other participants remotely located. Technologies not only include head-mounted displays exemplified in this research by the Oculus Rift, but also immersive virtual reality environments known as CAVE (cave automatic virtual environment). The maturation of immersive technologies has profound implications for the design and implementation of online education environments and subsequent pedagogies and active learning.

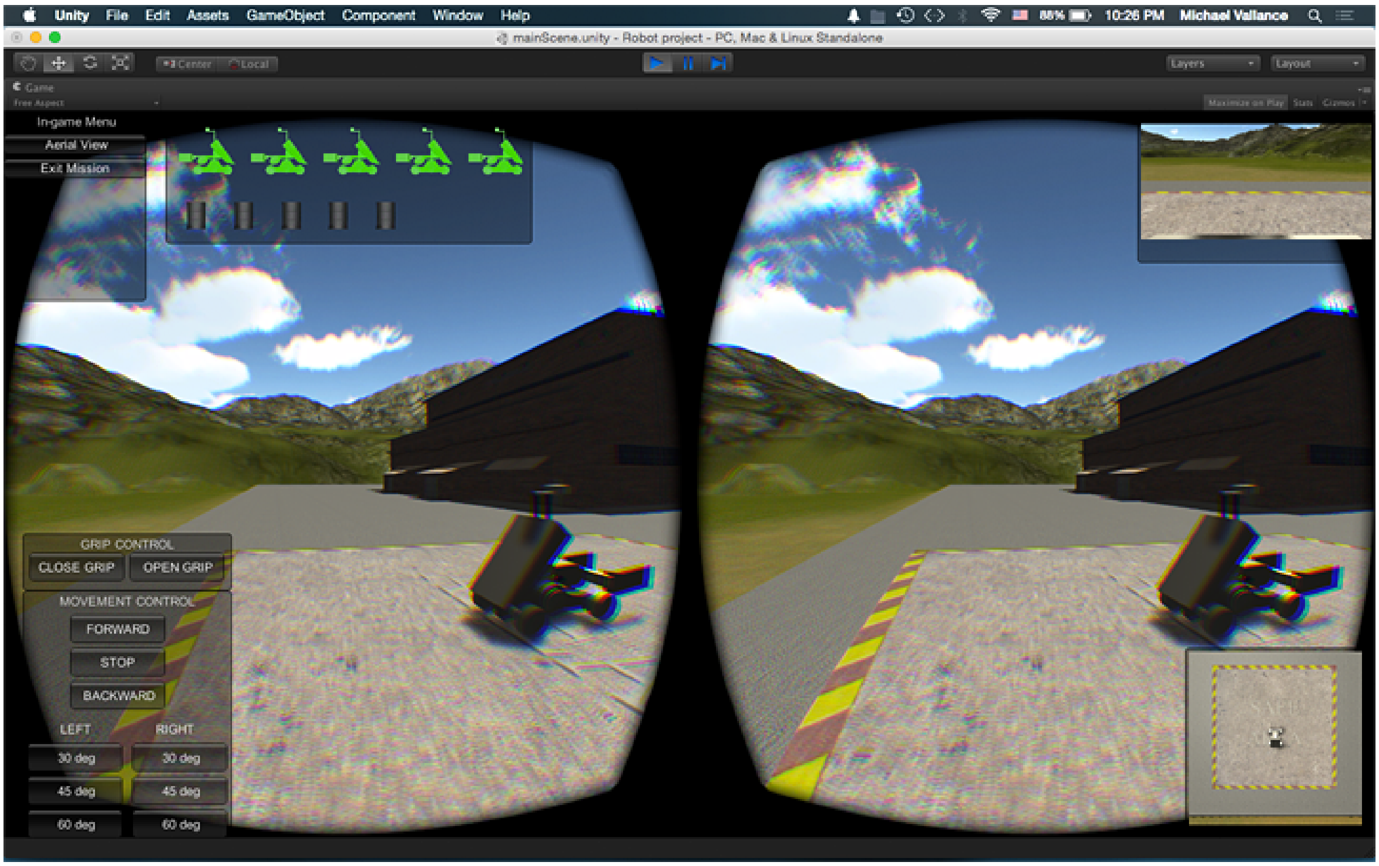

FIG. 7: The scenario is also viewed via the Oculus Rift 3D head-mounted display

Data is currently being collected as students in Japan and UK participate in tasks requiring collaboration and communication. Also, a comparison between the Fukushima scenario and the abandoned factory scenario will be investigated.

5. DISCUSSION

In order to capture data immediately after the completion of a task and while still in communication with their virtual collaborators in the virtual world, the students reported on the task's challenge and their skill in attempting the task. For "challenge" they had to report whether they considered the task difficult, demanding, manageable, or easy. For "skill" they had to report whether they considered their ability to undertake the task as hopeless, reasonable, competent, or masterful (Pearce et al., 2005). Once the task had been completed, students logged out of the virtual world and a general discussion of the task process and its outcome was held locally with the researchers. Immersion was then graphically illustrated using the Carli et al. (1998) eight-channel model of flow: arousal, flow, control, boredom, relaxation, apathy, worry, and anxiety.

Vallance et al. (2015) reported earlier iterations of the research. The participants were undergraduate students studying media architecture in a systems information science focused Japanese university (*n* = 6) and A-level students in UK studying science-based subjects (*n* = 10). Of the 16 participant students, two were female, 14 were male, all were between 17 and 19 years of age, and none had prior experience working with the project's technologies. A total of 56 robot tasks undertaken were analyzed.

The immersion of students within each task were calculated and graphically represented on the Carli et al. (1998) eight-channel model of flow (see Fig. 8). Tasks where participants were considered to be immersed (in a state of flow) were T5, T6, T7, T11, T14, T17, T18, T21, T22, T30, T35, T39, and latterly T47, T46, T41, and T53. These selected tasks of optimal flow are summarized in Table 2. Detailed task designs and learning analysis are beyond the scope of this paper but are explained in Vallance et al. (2015).

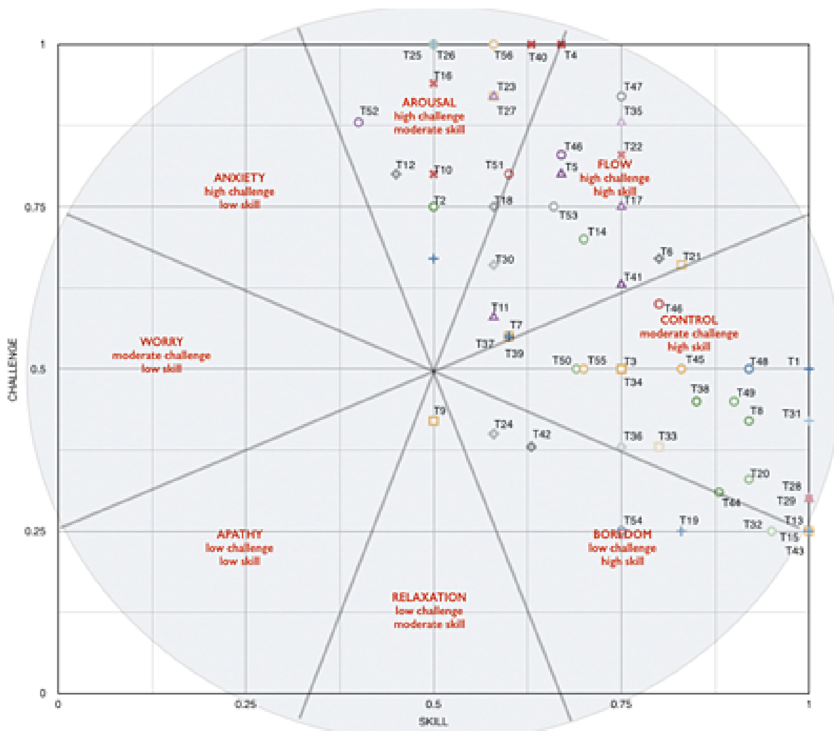

FIG. 8: Data of flow in tasks 1–56

TABLE 2: Selected tasks of optimal flow

Task summary		
T5: Program the LEGO robot to navigate a specified circuit around obstacles. JPN teaching JPN	T17: Suika robot. Rotate robot + follow line + use sensors to slice an object. Japan preparation.	T37: Program the LEGO robot to robot to move fwd + turn left + move fwd + turn left + move fwd + turn left + move fwd + turn right + move fwd + turn right + move fwd + stop (Pathfinder circuit). Use of color sensor.
T6: Program the LEGO robot to navigate a	T21: Suika robot. Rotate robo t+ follow line + use sensors to	T6: Program the LEGO robot to navigate a specified circuit around obstacles. JPN teaching JPN. T21: Suika robot. Rotate robot + follow line + use sensors to slice an object. Japan teach UK.

specified circuit around obstacles. JPN teaching JPN.	slice an object. Japan teach UK.	T39: Design and assemble a unique LEGO robot. Program the LEGO robot to move from start point + a sensor + a touch sensor + a move to an exact goal.
T7: Program the LEGO robot to navigate a specified circuit around obstacles using touch sensors. Locate and press OFF switch. JPN teaching JPN.	T22: Programming LabView for remote control of LEGO robot via OpenSim virtual robot for search and rescue.	T41: Design and assemble a unique LEGO robot. Program the LEGO robot to move two green objects from danger area to safe area. Use of sensors.
T11: Program the LEGO robot to maneuver a robotic arm. JPN preparation	T30: Program the LEGO robot to move forward (fwd) + sound sensor + stop + turn 90 deg + move forward. JPN teaching JPN	T46: Design and assemble a unique LEGO robot. Program the LEGO robot to move two objects from danger area to safe area. Use of sensors. Fastest time. JPN teach UK.
T14: Programming LabView for remote control of LEGO robot via OpenSim virtual robot.	T35: Program the LEGO robot to move fwd + turn left + move fwd + turn left + move fwd + turn left + move fwd + turn right + move fwd + turn right + move fwd + stop. Turns are not 90 degrees (i.e., Pathfinder circuit)	T47: Design and assemble a unique LEGO robot. Program the LEGO robot to lift one object from danger area to safe area. Use of sensors (including gyro).
		T53: Design and assemble a unique LEGO robot. Program the LEGO robot to move two green objects from danger area to safe area. Do not move the two red objects. Use of sensors.

Looking at the task summaries, a variety of sensors were used in these tasks. As the tasks became more complex, according to our robot task complexity criteria (cf. Vallance et al., 2015), the students indicated that even though the tasks were considered demanding they deemed their skills to be competent, thereby indicating some degree of development. However, in later tasks the students revealed that as the level of challenge increased (from manageable to difficult), their skill level in attempting to seek successful outcomes decreased (from competent to reasonable). Looking at the task communication transcripts and screen captures, it appeared that the students had to utilize different procedural knowledge involving, for instance, programming a touch sensor to coordinate with a motor action. These latter tasks required students to analyze and create unique solutions based on their prior task experiences and were thus deemed most challenging. The increased task complexity necessitated a higher level of programing skill incorporating sensor variables and loops. Although students' post-task reflection data revealed that they found sensor-related tasks difficult, being immersed in a task led to more active learning and, in turn, to greater student success.

To conclude this section, it is acknowledged that research into the efficacy of online 3D virtual collaborations for effective learning must be persevered in order to determine its value to educators and learners: "Even though video captures of robot movements and the online collaboration, transcriptions of in-world communication, and post-task reflections are collated as data for this research, at present the data only superficially demonstrates a development of procedural knowledge and collaborative fluency" (Vallance and Naamani, 2013, p. 72).

6. CONCLUSION

To conclude this paper, an attempt is being made to quantify the impact of active learning. By actively participating in online, international, 3D virtual tele-collaboration challenges, which include controlling basic robots within a simulated disaster zone, quantitative metrics of students' programming skills, and psychometric assessment of declarative, procedural and meta-cognitive knowledge are attempted to be measured. This is being undertaken through the design and iterative development of unique, 3D virtual world active learning activities for authentic, online, international collaboration, where participants are able to synergize engineering and science academic content with their learning processes. Much more work needs to be done and the research hypothesis remains inconclusive. However, for 3D virtual worlds to impact education, quantifiable metrics of learning are required. This research project is an attempt to deliver those metrics.

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REFERENCES

Anderson, L.W., Krathwohl, D.R., Airasian, P.W., Cruicshank, K.A., Mayer, R.E., Pintrich, P.R., Raths, J., and Wittrock, M.C., *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*, Longman, New York, 2001.

Arnold, L., Controlling Robots 6,000 Miles Away? No Problem! National Instruments Developer Zone, 2012, Accessed March 24, 2015; https://decibel.ni.com/content/groups/sweet-apps/blog/2012/03/15/controlling-robots-6000-miles-away-no-problem.

Barker, S.B. and Ansorge, J., Robotics as Means to Increase Achievement Scores in an Informal Learning Environment, *J. Res. Technol. Educ.*, vol. **39**, no. 3, pp. 229–243, 2007.

Battro, A.M., Fischer, K.W., and Lena, P.J., *The Educated Brain: Essays in Neuroscience*, Cambridge University Press, London, 2011.

Bloom, B.S. (ed.), *Taxonomy of Educational Objectives, the Classification of Educational Goals, Handbook 1: Cognitive Domain*, McKay, New York, 1956.

Carli, M., Delle Fave, A., and Massimini, F., The Quality of Experience in the Flow Channels, Csikszentmihalyi, M. and Csikszentmihalyi, I.S. (eds.), *Optimal Experience: Psychological Studies of Flow in Consciousness*, Cambridge University Press, New York, 1998.

deFreitas, S. and Neumann, T., The Use of 'Exploratory Learning' for Supporting Immersive Learning in Virtual Environments, Comput. Educ., vol. **52**, pp. 343–352, 2009.

Guizzo, E., Fukushima Robot Operator Writes Tell-All Blog, *IEEE Spectrum*, August 23, 2011, Accessed August 20, 2012; http://spectrum.ieee.org/automaton/robotics/industrial-robots/fukushima-robot-operator-diaries.

Hase, S., Learner Defined Curriculum: Heutagogy and Action Learning in Vocational Training, *SIT J. Appl. Res.*(Special Edition), pp. 1–10, 2011; Accessed May 16, 2016; http://sitjar.sit.ac.nz/SITJAR/Special/.

Jukes, I., McCain, T., and Crockett, L., *Understanding the Digital Generation*, Sage, Thousand Oaks, CA, 2010.

Knipe, D. and Lee, M., The Quality of Teaching and Learning via Videoconferencing, *Br. J. Educ. Technol.*, vol. **33**, no. 3, pp. 301–311, 2002.

Kolb, D.A., *Experiential Learning: Experience as the Source of Learning and Development*, Prentice-Hall, Englewood Cliffs, NJ, 1984.

Lui, A.K., Ng, S.C., Cheung, H.Y., and Gurung, P., Facilitating Independent Leaning with LEGO Mindstorms Robots, *ACM Inroads*, vol. **1**, no. 4, pp. 49–53, 2010.

Martin, S. and Vallance, M., The Impact of Synchronous Inter-Networked Teacher Training in Information and Communication Technology Integration, *Comput. Educ.*, vol. **51**, pp. 34–53, 2008.

Olsen, D.R. and Goodrich, M.A., Metrics for Evaluating Human-Robot Interactions, 2003, Accessed March 14, 2009; http://icie.cs.byu.edu/Papers/RAD.pdf.

Pearce, M. Ainley, M., and Howard, S., The Ebb and Flow of Online Learning, Comput. Hum. Behav., vol. **21**, pp. 745–771, 2005.

Schank, R., *Teaching Minds: How Cognitive Science Can Save Our Schools*, Teachers College Press, New York, 2013.

Towndrow, P.A. and Vallance, M., Making the Right Decisions: Leadership in 1-to-1 Computing in Education, *Int. J. Educ. Man.*, vol. **27**, no. 3, pp. 260–272, 2013.

Vallance, M., Design and Robots for Learning in Virtual Worlds, Khan, B. (ed.), *User Interface Design for Virtual Environments: Challenges and Advances*, McWeadon Education, Hershey, PA, pp. 268–284, 2012.

Vallance, M. and Martin, S., Assessment and Learning in the Virtual World: Tasks, Taxonomies and Teaching for Real, *J. Virtual Worlds Res.*, vol. **5**, no. 2, pp. 1–13, 2012.

Vallance, M. and Naamani, C., Experiential Learning, Virtual Collaboration and Robots, Jerry, P., Tavares-Jones, N., and Gregory, S. (eds.), *Riding the Hype Cycle: The Resurgence of Virtual Worlds*, Inter-Disciplinary Press, Oxford, UK, 2013.

Vallance, M., Naamani, C., Thomas, M., and Thomas, J., Applied Information Science Research in a Virtual World Simulation to Support Robot Mediated Interaction Following the Fukushima Nuclear Disaster, *Commun. Info. Sci. Man. Eng.*, vol. **3**, no. 5, pp. 222–232, 2013.

Vallance, M., Martin, S., and Naamani, C., A Situation that We Had Never Imagined: Post-Fukushima Virtual Collaborations for Determining Robot Task Metrics, *Int. J. Learning Technol.*, vol. **10**, no. 1, pp. 30–49, 2015.

Wing, J.M., Computational Thinking, Commun. ACM, vol. **49**, no. 3, pp. 33–35, 2006.

TEACHING RN-BSN STUDENTS COMMUNITY HEALTH USING AN IMMERSIVE VIRTUAL ENVIRONMENT

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Abstract

The Institute of Medicine made a recommendation in 2011 that 80% of all nurses possess a minimum of a bachelor of science in nursing degree by 2020. As a result of an influx of nurses returning to school, the shortage of public/community health clinical practice sites led to competition between schools for student placements in community settings. Finding appropriate clinical practice sites has become a challenge, not only for nursing students but also for students in all practice disciplines with a required clinical or practice experience component. Immersive learning in a virtual environment effectively addresses the problem of identifying and securing appropriate community-based sites for practice experiences and provides a safe environment for students to learn how to conduct a windshield survey. The use of virtual environments is not limited to nursing or health professions. Virtual environments can be used to supplement or enhance practice experiences for a variety of professions within and outside of the health-care spectrum. The development and implementation of a virtual environment is only limited by creativity, imagination, and finances. The cost to develop and implement a virtual environment can be managed by starting small and adding additional features over time.

KEY WORDS: community health nursing; immersive learning; virtual environment; windshield survey

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1. INTRODUCTION

Simulation, commonly used as a supplemental educational strategy to teach health-care professional students hands-on skills, has become a valuable tool to provide practical experiences in a safe environment before students are expected to function in real-world acute care clinical settings. Both high- and low-fidelity simulation is used across disciplines in hospital orientation programs to (i) test basic competence, (ii) practice emergency department or operating room scenarios, (iii) assess readiness for clinical environments (Neil, 2009), and (iv) teach interprofessional team communication skills (Calhoun et al., 2014; Severson et al., 2014). The purpose of this paper is to describe how an immersive virtual environment was integrated into a community health nursing course to teach nursing students community health nursing concepts. Students are being taught to conduct a windshield survey in an immersive virtual environment referred to as Sentinel City.

2. INFLUX OF REGISTERED NURSES ENROLLING IN BACHELOR OF SCIENCE IN NURSING PROGRAMS

Since implementation of the recommendation by the Institute of Medicine that 80% of all nurses possess a minimum of a bachelor of science in nursing degree by 2020 (Institute of Medicine, 2011) and the increase in the number of hospitals achieving magnet status (ANCC, 2014a), the requirement for bachelor prepared nurses has increased substantially. The American Nurses Credentialing Center (ANCC) Magnet Recognition Program requires hospitals to have a plan in place to reach the Institute of Medicine Future of Nursing goal to be granted magnet status, which is recognition of excellence for hospitals (ANCC, 2014b). This motivated a significant number of registered nurses to return to school. As a result, it has become increasingly difficult to find relevant clinical experience sites, also referred to as practice experience sites. To compound the problem, associate degree nurses enrolled in bachelor of science in nursing programs require a curriculum that provides additional knowledge competencies in community/public health nursing.

Typically, associate degree nursing programs do not include community health content because the focus of these programs is on the care of individual patients in acute care or long-term care settings. Community/ public health nursing is a community-oriented, population-specialty area that requires a minimum of a bachelor of science in nursing to work within this specialized field. Finding appropriate clinical practice sites in community settings has become a challenge and resulted in competition between schools for student placements in the community. In addition, appropriate clinical/practice experience sites for students in rural settings may be nonexistent.

3. NONTRADITIONAL STUDENTS

In addition to the challenge of securing appropriate practice experience sites in community settings, registered nurses who enter bachelor of science in nursing programs are often nontraditional students. The nontraditional student is usually older than the traditional student entering college immediately after high school, is employed full time, may have dependents other than a spouse, may be a single parent, and/or may be the caregiver for an elderly family member (U.S. DOE, National Center for Education Statistics, n.d.). Because nontraditional students have many obligations or potential geographical limitations, online education may be the only option (Killion et al., 2011). It is imperative that educators develop and implement teaching-learning strategies to meet the needs of nontraditional students and identify ways to address the problem of limited numbers of appropriate community health practice sites for registered nurses in bachelor of science in nursing programs. One way to address these challenges is by integrating an immersive virtual environment into current registered nurse to bachelor of science in nursing curricula.

4. IMMERSIVE LEARNG IN NURSING EDUCATION

The use of simulation in nursing education provides opportunities for students to learn and apply critical thinking skills and theoretical principles of nursing care in a safe environment. Immersive virtual environments can be used to teach community/public health concepts such as community assessment by conducting a windshield survey. According to Green et al. (2014, p. 135), “virtual worlds have the potential to offer nursing students social networking and learning opportunities through the use of collaborative and immersive learning.” Incorporating immersive learning in a virtual environment has several positive benefits for students, such as the convenience of carrying out a windshield survey during a time that is most convenient for working students without having to leave their home. In addition, immersive learning in a virtual environment effectively addresses the problem of identifying and securing appropriate community-based sites for practice experiences.

5. IMMERSIVE VIRTUAL ENVIRONMENT: SENTINELCITY

Sentinel City is a virtual environment developed by the American Sentinel University to represent what students would find in an urban city in the United States. This virtual environment provides students with unique opportunities to explore health and environmental issues facing American cities today. Students are able to take a tour around the virtual community while observing the environment and people of Sentinel City. Through observations, students gather information that helps them assess potential health issues and risks within this virtual environment.

FIG. 1: Sentinel City - Casper Park District

FIG. 2: Sentinel City - Bus Start Menu

6. COMMUNITY ASSESSMENT WINDSHIELD SURVEY IN A VIRTUAL ENVIRONMENT

6.1 WINDSHIELD SURVEY

A community assessment starts by conducting a windshield survey where students explore the eight subsystems of a community in the immersive virtual environment. A windshield survey is a composite of subjective data collected through personal observations. During a windshield survey, the observer uses sound, sight, and smell while riding, driving, and/or walking around a community. Windshield survey data of a virtual environment includes the observations and perceptions of what is observed, heard, or smelled—similar to what is observed in an actual community.

Another important part of a community assessment is the collection of objective data obtained from county, state, national, or federal sources such as demographic data from a state health department or census bureau. This information helps to define the assets of a community and changes that are needed to improve the health of the population in that community. Data from an actual community similar in size to Sentinel City is provided to students as a source of objective data.

In addition to the "people" (the core) of the community, there are eight subsystems that come together to form the assessment data for a windshield survey. Subsystems are individual yet integrated systems that contribute to the characteristics of every geographical community. The eight subsystems within every community include (i) physical environment, (ii) safety and transportation, (iii) health and social services, (iv) education, (v) recreation, (vi) politics and government, (vii) communication, and (viii) economics (Lundy and Janes, 2014).

6.2 ENTERING THE VIRTUAL ENVIRONMENT

Students start their windshield survey by reviewing an introductory video, then logging into the virtual environment and selecting an avatar. Students are able to personalize their avatar by selecting the gender. Once students have selected the gender of their individual avatar, the student is automatically placed on the city bus. Students select the speed of the bus, can stop the bus ride to take notes on what they observe, and can get off the bus and walk around the city. Students are encouraged to start their tour of the city on the slowest speed but can ride the bus as many times as needed to complete the windshield survey. There are buildings in the city that students can enter, such as a supermarket. Many different sounds, such as children playing, can be heard throughout the city. Although students may mute the sound, they are encouraged to listen to the different sounds as they tour the city. This would be expected when conducting a windshield survey in an actual community.

FIG. 3: Sentinel City - Avatar Selection

FIG. 4: Sentinel City - Bus Stop

6.3 COMMUNITY HEALTH NURSING COURSE: WINDSHIELD SURVEY ASSIGNMENTS

Students complete windshield survey assignments every other week of the eight-week community health course. The windshield survey assignments are divided into the following four assignments:

- Assignment 1: community core
- Assignment 2: physical environment, health and social services, safety and transportation
- Assignment 3: education, recreation, and politics and government
- Assignment 4: communication and economics

The course culminates with a final project, which is the development of a health education project that addresses the needs of a target population living in Sentinel City. The health topic for the project is based on the results of the students' completed windshield survey. Similar to assets or resources found in an actual community, students are instructed to assess and document the strengths (assets) as well as the limitation of resources in Sentinel City. As part of the final project, students include specific recommendations regarding the subsystems that should be strengthened to improve the health status of a people in Sentinel City. This information is shared with nursing administration so additional features can be added to the virtual environment.

6.4 VIRTUAL ENVIRONMENT AND OTHER COMMUNITY HEALTH COURSE ASSIGNMENTS

The use of a virtual environment in the course is not limited to the windshield survey assignments. An example of another assignment in the community health nursing course is a learning activity where students address one of the phases of disaster management, i.e., prevention, preparedness, response, or recovery. Students take a bus ride around Sentinel City to identify areas in the community that could potentially be the site of a man-made or natural disaster. Another assignment in the course is to select an infectious disease from the Centers for Disease Control (CDC) National Notifiable Infectious Condition website, an infectious disease that could potentially impact an aggregate living in Sentinel City. Students are required to develop, in layperson terms, a short public service announcement (PSA) that can be used to alert the residents about the outbreak of the selected infectious disease, which includes the signs and symptoms of the disease, and prevention measures, then determine the best form of media to share the PSA in Sentinel City. Students are instructed to take into consideration the lack of Internet access in the virtual environment, which further supports the authenticity of this virtual community because according to the Federal Communications Commission's 2015 Broadband Progress Report, approximately 55 million (17% or one out of six) Americans lack Internet access (FCC, 2015).

6.5 EVALUATION OF THE VIRTUAL ENVIRONMENT

Assessment of a virtual environment as a valuable teaching and learning strategy is ongoing. Students were initially required to take a pretest prior to being able to access the community health course. However, mechanisms were not put in place that required students to complete the posttest at the end of the course. Response rates on the posttests were low and faculty was not able to get an accurate assessment of the learning that took place as a result of using the virtual environment. Recently, questions to evaluate the value of using the virtual environment as a teaching tool were revised and two assessment questions are now embedded within several of the windshield survey assignments. Student responses to the first two assessment questions are provided below. At the end of each term, review and analysis of responses to all assessment questions is completed and results are shared at the assessment committee and nursing faculty meetings.

7. INITIAL STUDENT FEEDBACK

Student feedback about the virtual environment has been positive. Students ′state: “I like that I don′t have to get out of my pajamas to do the windshield survey.” “With my work schedule, I would not have been able to do the windshield survey. The virtual city made in easy for me to complete the assignments.”

In response to the question, “What did you find in the virtual city that will be most valuable in helping you understand how to do a windshield survey?” students responded: “The virtual bus tour was an excellent way to introduce a windshield survey and walk me through step by step of what to look for. I thought it was interesting just listening to the sounds of the city as the bus went through.” “I found that being able to move slowly through the city, being able to get around, and being able to pay attention to detail helped me get through sentinel city.” “I compared [the city] to a smaller version of NYC. The signs and advertisements helped. A windshield survey is data that is collected through observation and I really felt that the detail put into creating Sentinel City was amazing.” “Overall, participating in a Windshield Survey is interesting. It is like sitting in the park or at the mall and people watching.” “In the virtual city I was able to look around and see not just the people who live there but in the conditions their street and buildings are.”

On the final course project, students are asked to respond to the following question: In your prior nursing courses, you learned new concepts, theories, or patient care strategies using traditional methods such as course readings, lectures, PowerPoint presentations, or videos—how would you compare traditional methods to your experience in the virtual city? The following are examples of student responses to this assessment question: “Approach to learning about this subject has been excellent! I prefer this approach as opposed to power points, readings, etc.” “This type of virtual experience feels more hands on. I’d recommend it to anyone!” “Program was very interactive and educational. It built and challenged my assessment skills … thoroughly enjoyed this new learning approach … great method to encourage and support learning.” “Real life setting makes concepts easy to apply, content is driven by the student, not the teacher.”

8. CONCLUSION

Virtual environments can be used in a variety of programs outside of nursing and can be a valuable immersive learning experience for students in many different practice disciplines with a required clinical or practice experience component. The development and implementation of virtual environments is only limited by creativity, imagination, and finances. The cost to develop and implement a virtual environment can be managed by starting small and adding additional features over time. Examples of additional features that could be added to the virtual environment include interactive avatars, emergency alarm systems, community bulletin boards, and a chamber of commerce with historical information about the community. Integrating virtual environments in courses is an innovative teaching strategy that addresses the challenge of securing appropriate clinical practice sites in community settings that enhances learning not only for nursing students but also for students in a variety of practice disciplines.

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REFERENCES

ANCC, Frequently Asked Questions from the 2014 ANCC National Magnet Conference, American Nurses Credentialing Center, 2014a, http://www.nursecredentialing.org/Magnet/MagnetFAQs; Accessed on August 18, 2015.

ANCC, Magnet Recognition Program, America Nurses Credentialing Center, 2014b, http://www.nursecredentialing.org/Magnet; Accessed on August 18, 2015.

Calhoun, A., Boone, M., Porter, M., and Miller, K., Using simulation to address hierarchy-related errors in medical practice, *Permanente J.*, vol. **18**, no. 2, pp. 14–20, 2014.

FCC, 2015 Broadband Progress Report. Federal Communications Commission, 2015, https://www.fcc.gov/reports/eighth-broadband-progress-report; Accessed on August 24, 2015.

Green, J., Wyllie, A., and Jackson, D., Virtual Worlds: A New Frontier for Nurse Education? *Collegian*, vol. **21**, no. 2, pp. 135–141, 2014.

Institute of Medicine, Initiative on the Future of Nursing, *Recommendation 4: Increase the Proportion of Nurses with a Baccalaureate Degree to 80 Percent by 2020*, Institute of Medicine, 2011, http://thefutureofnursing.org/recommendation/detail/recommendation-4; Accessed on August 24, 2015.

Killion, C., Reilly, J., and Gallagher-Lepak, S., Becoming an "Onliner": Students' Perceptions of Moving from Traditional to Virtual Learning, *Online J. Nursing Informatics*, vol. **15**, no. 1, 2011; http://ojni.org/issues/?p=139.

Lundy, K.S. and Janes, S., *Community Health Nursing: Caring for the Public's Health*, 3rd ed., Jones and Bartlett Learning, Burlington, MA, 2014.

Neil, J.A., Simulation in Nursing Education, *Perioperative Nursing Clin.*, vol. **4**, no. 2, pp. 97–112, 2009.

Severson, M.A., Maxson, P.M., Wrobleski, D.S., and Dozois, E.J., Simulation-based team training and debriefing to enhance nursing and physician collaboration, *J. Continuing Educ. Nursing*, vol. **45**, no. 7, pp. 297–303, 2014.

U.S. DOE, Nontraditional Undergraduates/Definitions and Data, U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, November 1996, https//nces.ed.gov/pubs/web/97578e.asp; Accessed on August 24, 2015.

ONLINE LABS, CROWDSOURCED, CITIZEN SCIENCE, AND OPEN SCIENCE INITIATIVES—TEACHING SCIENCE IN THE DIGITAL AGE

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Abstract

This paper provides a brief introduction to the Online Laboratories stream.

KEY WORDS: summary, introduction, online labs

Devon Cancilla is the vice provost for Online Learning at the University of Missouri Kansas City. His particular interests are in open-science initiatives and how the online environment can be used to make laboratories and science more accessible. He was awarded the Online Learning Consortium's Effective Practice Award and the 2012 Outstanding Achievement Award in Online Education for his work in the development of online labs through the Integrated Laboratory Network initiative.

The objective of this stream is to highlight the extraordinary innovations occurring in online science education and to provide readers with practical examples necessary to help them effectively incorporate these innovations into their teaching practice. Almost without exception, the innovations that will be highlighted in this stream are driven through the use of technology. Why is this? Simply put, technology provides access, access promotes innovation, and innovation drives change. The goal of this stream is to be a catalyst for change in online science and laboratory-based education.

Why is this stream needed and how will it be developed? Back in 2007 while speaking about undergraduate science and laboratory education in the United States, Myles G. Boylan of the National Science Foundation stated.

In almost every discipline, I could point to a variety of really effective, wonderful sets of instructional materials and instructional practices, and say that if we could magically click our fingers and get everybody using them, there would be a huge improvement in undergraduate education that would happen instantaneously, but we're nowhere near that (Chronicle of Higher Education, *The Tough Road to Better Science Teaching*, August 3, 2007).

Recognizing that innovation will not happen instantaneously, I believe there is a real need for a resource where online practitioners can exchange ideas, present works in progress, and show both their achievements and failures. In short, there is a need for a community of practice and the time now is right. We are witnessing the development of an incredible number of crowdsourced and citizen science initiatives, many of which will be highlighted in this stream. So why not a crowdsourced community of practice focused on online science education? That is my hope for the development of this stream: that a community of practitioners will develop who will be engaged and willing to share their ideas, and where the community will have input into the development of the stream and its content.

I also believe it is important to show both the ideas that work and the ideas that do not seem to work. The important point is the ability to explain why and provide the community a chance to contribute to that explanation. This means that the papers appearing in this stream may not always fit the mold of a traditional academic journal. Papers will be peer reviewed but may not represent the end point of a definitive study. For example, it may be important to highlight a particular milestone in a multiyear project or a particular observation that may change the direction of a project. There may also be the case where the author acts more like a correspondent, bringing together the work of others in a way that provides a reasoned approach or argument. The stream will be a continuous work in progress that will evolve based on the needs of the community.

At the end of the day, we will have met our objective when we see a growth in the number and breadth of submissions related to science education. Our goal will be achieved when we observe the development of a vibrant, innovative community of practice actively engaged in bringing about change in online science education.

THINKING OUTSIDE OF THE LAB: SPECIAL CONSIDERATIONS FOR LAB COURSE REDESIGN

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Abstract

Course redesign has traditionally focused on lecture-style courses, while laboratory courses have received comparatively little attention. The Missouri University of Science and Technology's Delivering Experiential Labs to All initiative is a model for redesigning lab courses to more effectively present lessons in contexts where use of specialized equipment is impractical or unnecessary through the use of blended and online laboratory courses. Special considerations arise when applying redesign strategies to such laboratory environments. This paper focuses on several details of instructional design that differ in laboratory courses when compared to the creation of blended and online lecture materials. While focusing on the practical issues that enable implementation, the author also emphasizes that the willingness to experiment and adapt over the course of multiple attempts are the key qualities that will help other programs with their own redesign efforts.

KEY WORDS: online, laboratory, experiential, Missouri, technology, science, curriculum

Amy Skyles currently works for Missouri S&T as an Instructional Designer and is also an adjunct instructor for the Department of Biological Sciences at S&T. She holds a BS in biological sciences from Missouri S&T and a MEd from Drury University. Amy also holds a certificate as an online educator through the University of Missouri Columbia. She also has several hours of graduate credit in the Masters of Public Health Program from the University of Illinois at Springfield. She has worked in the field of education since 2003, in both K–12 and higher education.

She has a passion for learning and considers herself a lifelong learner who is perpetually trying to discover new things and new ways of doing the things that she has already made a part of her life. Teaching and learning are both very enjoyable for Amy and she is greatly interested in transitioning blended and online course materials as a standard way of teaching instead of as a new or emerging type of instruction.

As the primary investigator for the Transforming Instructional Laboratories project, Amy has developed an expertise in laboratory redesign practices using best pedagogical methodologies. Amy is recognized as the go-to person on the S&T campus for learning about instructional design of laboratory courses, including DELTA labs, which strive for the goal of delivering experiential labs to all.

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1. INTRODUCTION

Lecture course redesign is old news; many institutions have redesigned lecture courses. At the Missouri University of Science and Technology (S&T), efforts have been made to think outside of the box by thinking outside of the lab. The Delivering Experiential Labs to All (DELTA) initiative is driving laboratory course redesigns in several departments across campus, and has resulted in some great changes and improvements in the way the university's labs are being designed and delivered.

The project began in late 2013, when instructional designers first approached faculty with the idea to form blended and online labs. Many were initially hesitant. What they had seen of course redesign in the past typically included large, gateway lecture courses that were filled to capacity. The redesign of lecture courses was simple and well documented, and such redesigns had been done successfully for quite some time by campuses across the country, including Missouri S&T. What faculty were being asked to do, though, was to look at highly customized lab courses in their field of expertise and make changes based on the advice of an instructional designer who had little or no subject-matter expertise.

Branding of the redesigned labs was the first potential setback in Missouri S&T's endeavor to transform the way laboratory courses are delivered. The project needed an "elevator speech" to pitch to faculty, and it was not sufficient to merely state that the campus needed to create online labs, because "online" was not a term faculty were willing to accept for experiential learning activities.

The result was DELTA: courses that could be online, blended, flipped, or presented via any other appropriate delivery mode. The defining characteristic is that these labs are what they need to be, not what they always have been.

Labeling the new labs DELTA courses changed perceptions and smoothed the pathway to begin redesigning additional lab courses. It also drove home a lesson to the instructional design team—in the words of Ken Robinson in his 2006 TED Talk titled *How Schools Kill Creativity*, "If you are not prepared to be wrong, you will never come up with anything original" (Robinson, 2006). This became a guiding principle behind all of the lab redesigns: try something, and if the effort is unsuccessful, try it in a different way. But never be afraid to try.

Through this process, several other lessons specific to laboratory course redesign have been discovered as well. These findings and considerations are outlined below. There is no definitive hierarchy to this list, though some considerations are more urgent than others.

2. PEDAGOGY DRIVES COURSE DESIGN

At the center of many traditional laboratory activities are specialized pieces of laboratory equipment. For example, the Missouri S&T Mechanics of Materials course involves bending, stretching, and breaking various metals. This experimentation is not easily done at home. In this example, the technology available in the laboratory, rather than pedagogy, has traditionally driven instruction. Accordingly, when the redesign process began, a number of important questions related to laboratory were considered, including the following:

- Do the labs which use this machinery contribute to the course goals?
- Do students need to know how to run the machinery?
- Is this knowledge essential to student advancement in the field?
- Are students actually running the machinery now, or is that the job of the instructor or TA with students simply documenting what they observe or recording numbers?

Ultimately, the guiding question is: if the students aren't actually doing anything, are they learning optimally? Research dictates that active-learning techniques presented in learning environments such as lab courses lead to higher overall scores when compared to lecture-based courses, and active learning strategies lead to learning on deeper levels (Hackathorn et al., 2011). Furthermore, some engineering experts believe that advanced instrumentation and data acquisition procedures can lead to a feeling of detachment by students from the needed experimentation (Muscat and Mollicone, 2012). In an effort to enhance learning in the Mechanics of Materials course at the University of Malta, experimentation practices were evaluated and the determination was made to provide students with the opportunity to design and implement their own experiential learning. The results presented with a high level of student satisfaction (Muscat and Mollicone, 2012).

For the Mechanics of Materials course at Missouri S&T, it was determined by the instructor that each lab conducted in class could be conducted using different materials purchased mostly from hardware, convenience, and/or grocery stores (Table 1). The resulting design innovations inspired a lab kit (Fig. 1) that students who are not on campus can use to do science anywhere. And, because this equipment is found at local stores, students can easily purchase their supplies from a list provided by the instructor.

TABLE 1: Sample kit components: Mechanics of Materials

Experiment names	Items needed	Approximate cost
Spring Constants, Linear Regression	Springs	$53
	Weight Set (purchased online)	
	Caliper (purchased online)	
	Hook	

Direct Sheer Stress, Bearing Stress	Cookie cutter set	$9
	Play-Doh	
	Modeling clay	

FIG. 1: Mechanics of materials spring constants and linear regression kit components; photo courtesy Jeff Thomas, Missouri S&T

The aforementioned list of supplies was cautiously designed. Students are not expected to purchase costly materials for a singular use. Each lab attempts to include materials that will be beneficial for the student in one of two ways, namely, the materials may be used in more than one lab or the kit might include items that the student will actually need after graduating, such as calipers and weight sets. The nature of this course prevents concerns for disposal of materials and waste. In other courses, however, disposal and waste play a key role in the lab design.

3. LABORATORY SAFETY AND MATERIAL DISPOSAL

The first semester General Chemistry lab on the S&T campus is blended. Students attend half of the scheduled class sessions in the traditional lab where they perform experiments that cannot be transformed for delivery outside of such a controlled environment, typically due to safety concerns. The remaining half of each student's coursework is completed using kits that the students take to common areas on campus, often dorm facilities. These kits are designed to allow students to perform experiments that do not necessarily need to be conducted in a lab. To use an example from the equipment issue discussed above, General Chemistry students do not need expensive laboratory spectroscopes to learn spectroscopy (Fig. 2). Instead, they can build their own spectroscopes for just over $1 using a small piece of plastic tubing, black paper, and a polarizing filter. In designing their own equipment, students are also learning more about how the spectroscope works. Student learning in such instances is actually increased by eliminating the more expensive technology.

FIG. 2: General Chemistry cell phone spectroscope

The notion of labs conducted in common areas led to the next point of concern. On hearing of chemistry occurring outside of classroom lab spaces, the Environmental Health and Safety office quickly responded to the instructors with inquiries about the course. The two key concerns were student safety during the activity (for students conducting the lab as well as students who may be in the common areas for other reasons) and disposal of waste after the completion of the activities.

First, the safety for each lab activity was individually considered. If a lab activity required specialized safety equipment that could not be reasonably provided outside of the lab, then that particular lab was completed in the traditional lab environment. Several lab activities, however, were transformed to be conducted outside of the traditional space. Two examples of labs that provide fundamental skills but do not necessarily require a structured lab environment are the spectroscopy lab mentioned previously, and the paper chromatography lab. However, oftentimes, these examples of safer labs still include waste components. In larger quantities, these wastes could pose a hazard, and each potential risk needed to be analyzed separately.

For example, both the General Chemistry kits and the General Biology kits used at Missouri S&T are at least partially created by a vendor, which produces microscale quantities for students to use for experimentation outside of the lab (see Fig. 3). The difference between how the two courses have been designed, however, has created a need for distinct disposal procedures.

FIG. 3: General Biology macromolecules lab, hands-on labs; photo courtesy Terry Wilson, Missouri S&T

The General Biology kits are sent directly to the student and are designed to be completed by an individual. The biology class is also a low enrollment course (approximately 20 students in a full section). Because any chemicals in need of disposal are being done so in microscale quantities by one individual, there is not a strong concern for disposal. An entirely different scenario unfolds in the General Chemistry lab course.

On the S&T campus, General Chemistry serves over 1200 students from various departments per year. As a freshman-level course, General Chemistry typically includes students who are also living in residential housing on campus. The safety burden arises when several hundred students are completing their lab experiments in the dorms during the same week. The safely disposable microscale quantities may pose a greater risk if several hundred students are disposing of them in the same dormitory facility.

The solution for the General Chemistry lab is uncomplicated. Because this course is blended, the students do come to the traditional lab every other week throughout the semester. After completion, students return the entirety of the used kit, including waste materials, gloves, and all packaging, to the lab. Students are required not only to submit a lab report, but they also must properly dispose of all waste materials. This disposal procedure prevents larger quantities of waste elimination in the dorms while it serves to reinforce the proper disposal techniques that students are required to learn using guidelines set forth by the American Chemical Society.

The return of the chemistry equipment also serves to fulfill another goal, i.e., reduction of waste and promotion of environmentally sound practices. By returning the kits, all non-consumable materials that might be reused, such as glassware, are also returned. As a result, the Chemistry Department is able to reduce purchasing costs by filling kits with non-consumable materials from previous semesters. This leads to the discussion of responsibility for the purchase of materials in redesigned DELTA courses.

4. PURCHASE AND DISTRIBUTION OF LAB MATERIALS

Currently, it is up to each academic department to determine a purchasing model for their laboratory components. For DELTA labs, there is interest in having the student pay, and there is also interest in departmental payment—but who actually purchases the materials is not just about financing. Some of the redesign factors previously discussed influence this decision as well.

The General Biology lab course was the first to consider using kits for a fully online DELTA lab. In this case, the students are using the kit as a replacement to the lab manual that was traditionally used. Because students are no longer purchasing a lab manual, those in the online section of the General Biology lab are purchasing their own kits directly from the vendor.

This method of kit delivery was selected for various reasons. First, instructors prefer to keep the cost of the kits as low as possible. Using a secondary vendor on campus, such as the academic department or bookstore, would increase costs as well as promote storage concerns—these kits are not all small enough to fit on a bookshelf or in current storage facilities. The second reason is due to the very nature of these kits. Many kits contain perishable materials. If an overabundance of kits is purchased to meet the needs of a course for any given semester, kit components may not be easily preserved until the following semester. Finally, lab kit vendors update the documentation for their kits frequently. If the kits are purchased directly from the vendor, any updates that occur during the progression of the semester can be more easily communicated to the students by the vendor.

When the General Chemistry redesign began, a different purchasing model was adopted. Because the course is blended, the department is saving classroom space and reducing purchasing costs by replacing some of the larger machinery and equipment with modestly priced kit components. As a result, the Chemistry Department was able to use these cost savings as one reason to justify the departmental purchase of the kits. Other arguments in support of departmental acquisition of the kits were revealed in the early stages of the redesign as well.

One factor involves the vendor distribution processes. Vendors that produce lab kits for out-of-the-lab experimentation produce them to be shipped to the students as entire semester kits. Because the chemistry students in the blended lab at Missouri S&T need to acquire the individual lab exercises one at a time from the department, the prepackaged kits have to be deconstructed by chemistry department staff before distribution to the students. This additional process requires much more manpower and time than the model used by the Biology Department, where the kits are shipped directly from the vendor to the students. The deconstruction and reassembly is also only possible if the Chemistry Department purchases the kits. Also, if this step were eliminated and the kits were shipped directly to students, the concerns of the Environmental Health and Safety office on campus would potentially become realized with students living in residential housing on campus.

Another aspect of the chemistry kits that is important to note is that because the kits are being dissected into individual labs, it is obvious that each kit presented to students does not encompass an entire course. The notion that a kit is not an entire course is more difficult to distinguish in the biology kits, which are shipped in their entirety to the students. The next lab redesign consideration addresses whether the kit alone is, in fact, the course.

5. DESIGNING A COURSE USING KIT COMPONENTS

If the laboratory kit model is selected, it is very important to note that a kit does not make a course. Kits, whether designed by a vendor or an instructor, contain materials and procedures. A course contains goals, learning objectives, and instructions for achievement. In order to measure the quality of a course, instructors and instructional designers at Missouri S&T have developed a course evaluation guide. The guide is based on the Quality Matters rubric, but tailored to our specific campus needs. No kit that has ever been tested fully meets all of the components of the Missouri S&T course evaluation guide. Accordingly, the course goals and learning objectives, which are developed before any instructor ever even looks at any kits, are measured against the kits provided by vendors. Gaps are identified and new content is created to fill those gaps.

For example, the General Biology kits offered by Hands-On Labs do not offer a satisfactory and cost-efficient microscopy unit. Because the General Biology DELTA course is for nonmajors, it also is not feasible to have those students purchase their own microscope. With the assistance of a graduate student, the instructor found plans for a $10 smartphone microscope on Instructables (Instructables, 2015) (see Fig. 4). In practice, the students have rarely been able to build this microscope for $10 (the typical cost is around $14), but when compared with the microscopes in the traditional lab, the instructor and students were very pleased with its performance. This small addition to the vendor's kit has received recognition from numerous sources and has been featured in publications including Campus Technology (2014), Eduwire (2015), and *Lab Manager* (2015).

FIG. 4: $10 microscope used in General Biology laboratory course

Another more recent example of kit customization is the development of a $1 spectroscope for General Chemistry (see Figs. 5 and 6). Like the $10 microscope, the spectroscope uses a smartphone as a platform for data collection. The spectroscope is being built from polarized film and inexpensive tubing and the spectrum is viewed using the camera on a phone or tablet. This innovation did not stem from a gap in the kit contents, but innovations by the redesign team led to the discovery of a way to modify a component in the kit and make it more affordable. Initially putting the spectroscopy activity into a kit cut the cost dramatically, and now, because of continued brainstorming and development, the cost for the exercise has been decreased for a second time.

FIG. 5: Halogen light spectroscope image; courtesy Klaus Woelk, Missouri S&T

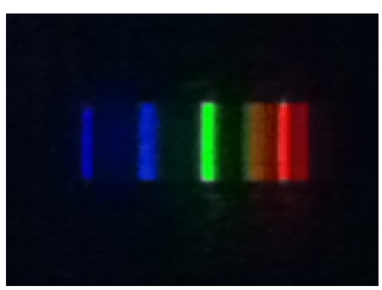

FIG. 6: Compact fluorescent light spectroscope image; courtesy Klaus Woelk, Missouri S&T

6. ADA COMPLIANCE

As new ideas are developed, it is essential to understand that some students are more technically savvy than others and some are similarly more adept at manipulating tools and machinery to effectively build their own lab equipment. Not everyone can be expected to build these additions to the vendors' kits. Consider students with disabilities. What if a student has fine motor skill impairment? If such a student receives instructions for creating experimental equipment (such as the $10 microscope or the inexpensive spectroscope) and they are physically unable to do so, the university has done this student a disservice.

DELTA labs strive to deliver to all. Considerations for disabilities in course design, as with all other courses, are essential. There are several different aspects to disability support that must be recognized. As mentioned above, if a student has a fine motor skill impairment, accommodations must be made. How does that student build or manipulate equipment outside of the lab? Does he need a partner? Does this partner need to be enrolled in the class, or is a family member or roommate sufficient? What if the student is blind? Does a particular disability only require extra time for completion of assignments? What if there is a set time for a procedure or the need for measurable milestones along a timeline? What is done in these situations and how will these issues be addressed?

There are numerous questions surrounding disability and it is impossible to predict all of them in advance. One idea under contemplation relates back to the safety issues mentioned before. The General Chemistry instructors have made it clear to their students that it is not safe to do chemistry experiments alone. Each chemistry student is assigned a partner. Disability accommodations can often be alleviated by doing lab work with a partner, as long as the student with the disability is willing to share this information.

The students who are completing their work off campus and without a partner may have additional disability support issues. Because preparations cannot be made for every situation, it is important to have a general plan in place. Currently, discussions occur with each instructor in regard to the accommodations they would feel comfortable with. In the event that a student would approach them with a disability concern, the instructor can then be prepared with some ideas for accommodations that might be acceptable.

There are also several course design practices that instructional designers help to apply to all of the course redesigns at Missouri S&T, both lecture and lab, to help with disability concerns. Instructors are encouraged to use online tools that meet disability standards. Such tools include the learning management system (LMS), online homework platforms, and supplemental sites provided by textbook publishers or lab kit companies. The Educational Technology department also offers a service to closed caption any video content created by the instructor. Experience with captioning for disability support has proven that it is much simpler to do so in advance, even if an immediate need is not present, than it is to modify the content once a need is identified.

Another benefit of video captioning has become evident as well. The international student population at Missouri S&T is growing rapidly. Feedback from international students confirms that this population of learners greatly appreciates the captioned video content. These students are able to hear and see the words, which is extremely helpful when engaging with new content, especially if the content is not in a learner's native language.

Disability and communication concerns definitely present a "last, but not least" area of focus for any course redesign project. A culture of acceptance on college campuses has led to a great deal of innovation to provide educational opportunities for those with disabilities. What higher education is looking for now is innovation in all areas of education—a mass movement, if you will—to provide accessibility of all types of courses to all populations of learners. That is what DELTA is doing, delivering experiential labs to all.

7. CONCLUSIONS

Several conclusions emerged from the experimentation described. First, laboratory redesign does not require use of existing laboratory facilities. Laboratory activities that do not require specialized equipment are, in fact, often better able to accomplish course goals when conducted outside of the traditional lab classroom. Second, costs of laboratory delivery can be significantly reduced through the use of innovations such as the replacement of instrumentation with inexpensive alternatives from hardware stores or methods that utilize smartphones and tablets. Such methods make use of technology that is readily available to most students and little assistance is needed for students to master the learning requirements created when smartphone devices are used for learning. Third, laboratory kits work well and can be used at home to augment online instruction, thus truly making laboratory activities available to an expanded audience of learners. Fourth, continued experimentation is needed for the laboratory redesign. Each redesign project must be evaluated annually to determine if new methods and technologies can replace former lab components.

8. THE FUTURE OF LABORATORY INNOVATION

In *The True Believer*, Eric Hoffer (1951) described the nature of mass movements—who is involved, what roles they might play, and what outcomes can be expected. The principles of mass movement described by Hoffer are applicable in this arena all too clearly. Hoffer said, "Fear of the future causes us to lean against and cling to the present, while faith in the future renders us receptive to change" (Hoffer, 1951, p. 9). Change is significant in the evolution of laboratory course design. In science, what is the symbol for change? The answer is Δ.

The delta symbol is the accepted symbol for change, so it was the logical place to begin this revolutionary journey. Using best pedagogical practices, Missouri S&T is evaluating courses and discovering new pathways for accomplishing the course goals in all redesigned courses, not just the lectures.

As innovative course design drives change in online education, keep in mind, "Nothing so bolsters our self-confidence and reconciles us with ourselves as the continuous ability to create; to see things grow and develop under our hand, day in, day out" (Hoffer, 1951, p. 38). At Missouri S&T, the processes used to create DELTA labs have been documented in order to create a collection of redesign guide sheets. This collection is being piloted at Missouri S&T and will eventually serve as a course redesign handbook for use by any instructor or instructional designer interested in laboratory course redesign.

These guides provide templates for each process of the redesign from the development of course goals and outcomes to the analysis and evaluation of the redesigned lab. Throughout the redesign process, instructors are provided with customized reports and steps for completion of pedagogical necessities.

As the development of DELTA labs continues at Missouri S&T and the handbook of guide sheets is completed, knowledge sharing with other STEM institutions will play a pivotal role. Expansion of the collection of knowledge resulting from successful practices developed by this project will serve to expand the reach and educational potential of multiple institutions, and truly result in delivering experiential labs to all.

REFERENCES

Campus Technology, This Flipped Class Is Studying Biology with a $10 Microscope and a Smart Phone—Campus Technology, Accessed April 8, 2015; http://campustechnology.com/articles/2014/08/19/this-flipped-class-is-studying-biology-with-a-$10-microscope-and-a-smart-phone.aspx

Edwire, This Flipped Class Is Studying Biology with a $10 Microscope and a Smart Phone, Accessed April 8, 2015; http://www.eduwire.com/technology/this-flipped-class-is-studying-biology-with-a-10-microscope-and-a-smart-phone/

Hoffer, E., *The True Believer: Thoughts on the Nature of Mass Movements*, Harper and Row, New York, 1951.

Instructables, $10 Smartphone to digital microscope conversion! Accessed April 8, 2015; http://www.instructables.com/id/10-Smartphone-to-digital-microscope-conversion/

Lab Manager, University Pilots Online Laboratory Course—Lab Manager, Accessed April 8, 2015; http://www.labmanager.com/news/2015/02/university-pilots-online-laboratory-course?fw1pk=2#.VSWKleF5_K2

Muscat, M. and Mollicone, P., Using Kolb's Learning Cycle to Enhance the Teaching and Learning of Mechanics of Materials, *Int. J. Mech. Eng. Educ.*, vol. **40**, no. 1, pp. 66–78, 2012.

Robinson, K., How Schools Kill Creativity, TED Talk, 2006, Accessed April 8, 2015; http://www.ted.com/talks/ken_robinson_says_schools_kill_creativity#t-329684.

MAKING SCIENCE MORE ACCESSIBLE: DIY SMARTPHONE CONVERSION BRINGS MICROSCOPY TO THE MASSES

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Abstract

Nearly two years ago, I built the first prototype for a smartphone microscope conversion stand. Since the instructions were posted online, nearly two million people have watched the assembly video and teachers, students, and professionals have written to me from four continents to say how they have used the design, sometimes altering it to suit their specific needs, and passed it on to others. I am a major proponent of making home science more accessible. This DIY microscope stand will convert any smartphone or tablet with a digital camera into a digital microscope with magnification up to 325×. Its low cost and durable design make it ideal for teaching applications both inside and outside the classroom. And its features — especially when compared to more expensive optical light microscopes — makes it a viable substitute for underfunded classrooms as well as professionals outside the field of education.

KEY WORDS: Microscopy, Microscope, DIY, Smartphone, Education

1. INTRODUCTION

Nearly two years ago, I built the first prototype for a smartphone microscope conversion stand. Since the instructions were posted online, nearly two million people have watched the assembly video and teachers, students, and professionals have written to me from four continents to say how they have used the design, sometimes altering it to suit their specific needs, and passed it on to others.

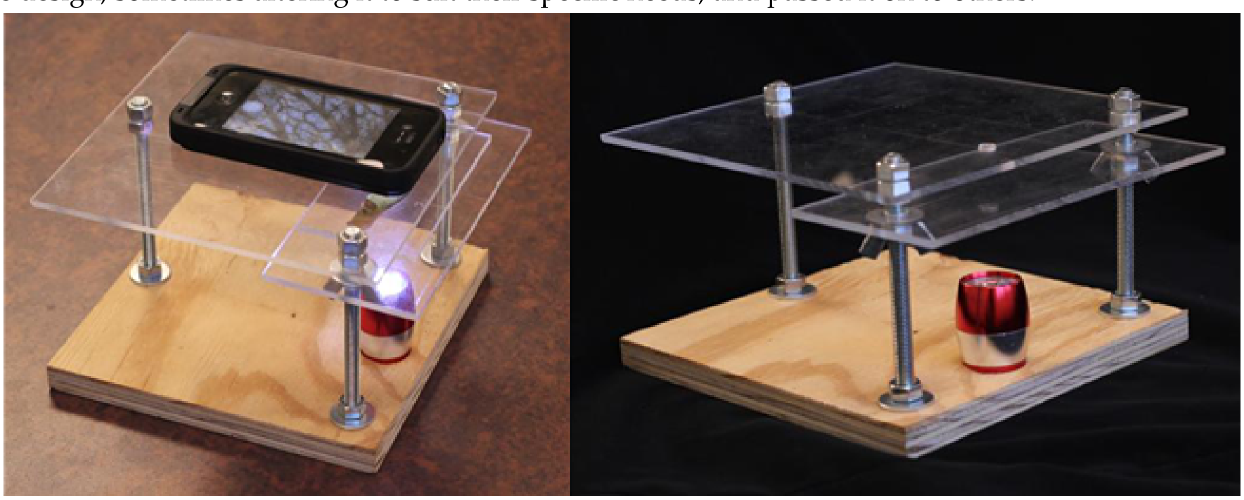

FIG. 1: Smartphone Microscope. Luke Saunders

I am a major proponent of making home science more accessible. This DIY microscope stand will convert any smartphone or tablet with a digital camera into a digital microscope with magnification up to 325×. Its low cost and durable design make it ideal for teaching applications both inside and outside the classroom. And its features—especially when compared to more expensive optical light microscopes—make it a viable substitute for underfunded classrooms as well as professionals outside the field of education.

2. BACKGROUND

In the fall of 2013, I noticed a project on an online forum I frequented. People were taking macro photos using their smartphones and the collimating lens from a laser pointer. It was a simple enough project. All you had to do was tape a bobby pin onto the back of your smartphone with the widest part over the camera lens. You could stick the lens between the two prongs of the bobby pin and have a functioning macro camera. Sort of.

It was a very simple hack, but difficult to use. Because the focal length of the lens was so small, it was difficult to get a shot into focus and hold the phone still while taking a picture. Eventually, I placed the phone on a wooden block on my desk to stabilize it, but then I could not adjust the focus. I put a coin I was trying to photograph on a notebook and by changing the number of pages under it, was able to raise it by a few thousandths of an inch. This method provided the necessary fine adjustment required for focus, but it was tedious and inefficient. There was also the issue of lighting. The focal length of the lens was incredibly short, to the point that it had to be practically on top of whatever I was trying to photograph, cutting off most light to the specimen.

As I was trying to find possible solutions to each of these problems—a stage for the camera, an external light source, and an adjustable specimen stage—I realized that what I was really doing was designing a microscope. A few quick calculations showed that the magnification was greater than 100×, more than enough to view plant cells.

I sketched a few possible designs and set off for the hardware store. Twenty minutes of pacing the aisles ended with my carrying out a keychain flashlight, nuts, bolts, plywood, Plexiglas, and a couple of extra laser pointers. Later that night, I was looking at red onion epidermal cells and my own cheek cells with my iPhone.

Using calibration micrometer slides, I determined that one laser pointer lens can provide up to 175× (with the phone's digital zoom). The addition of a second lens stacked on top of the first increases the magnification to approximately 325×.

Compared to other microscopes, this design is very inexpensive. It only costs about $10 to build and can be easily assembled with minimal usage of power tools. The stand does require a smartphone or tablet with a camera to function, but many students and teachers own and carry such devices regularly.

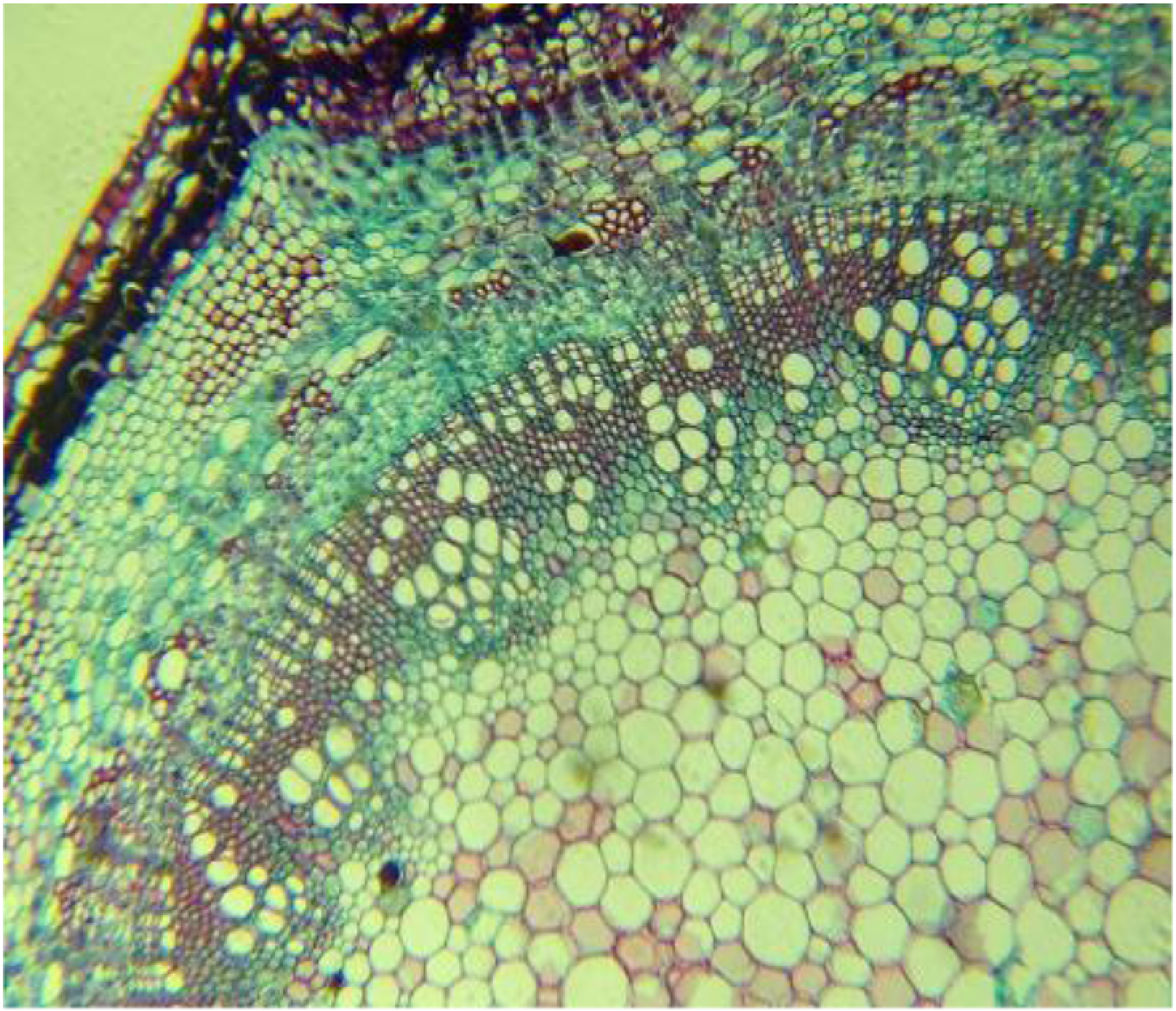

FIG. 2: Elderberry 275×. Kenji Yoshino

Its use of smart devices actually makes it far more intuitive to use than other microscopes. The smartphone interface is one that most students are becoming increasingly familiar with. The autofocus feature on the camera also does much of the fine adjusting for the user. And manipulating specimens is more intuitive because moving a sample results in the image moving in the same direction.

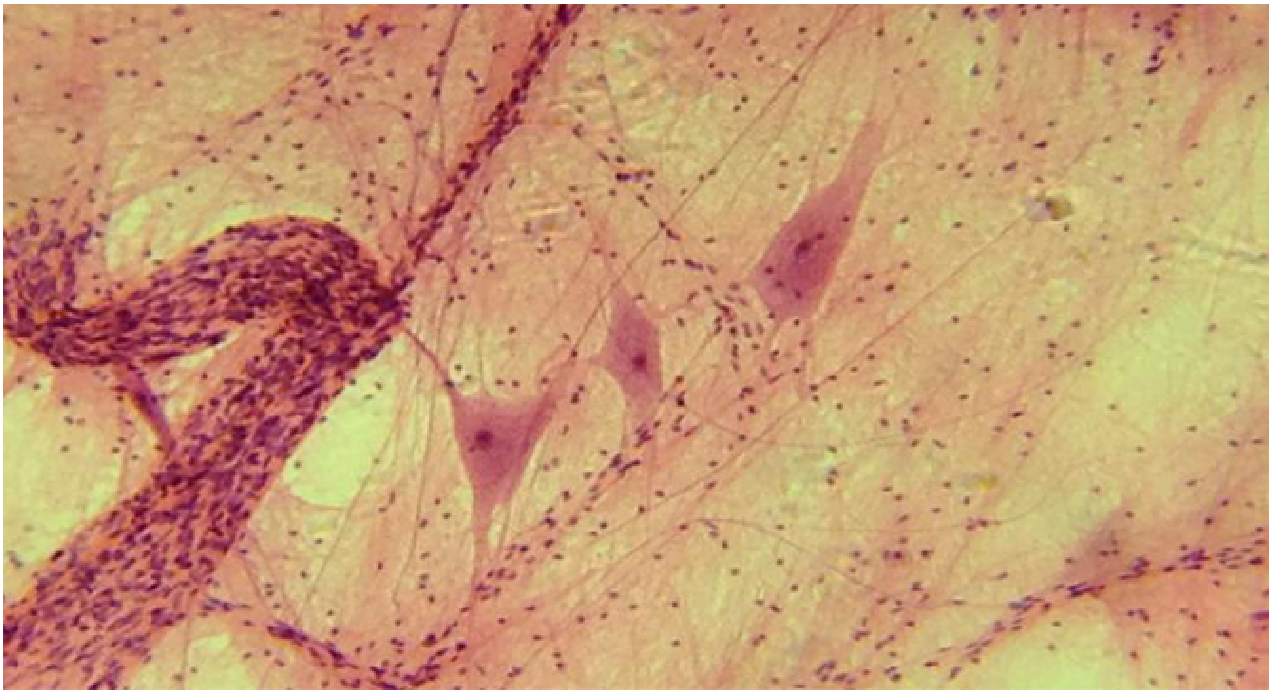

FIG. 3: Human motor nerve 275×. Kenji Yoshino

Because this design allows viewing on a smartphone screen, students do not have to take turns looking into the eyepiece of a conventional microscope. Multiple students can view the specimen at once. When I demonstrate the microscope's functions at science outreach events, I often hook my phone up to a projector so that an entire room can see what is being viewed. This microscope also allows users to take photographs or video, which can be accessed at any time. The photos can be printed, digitally altered, and have even been used as the basis for art projects.

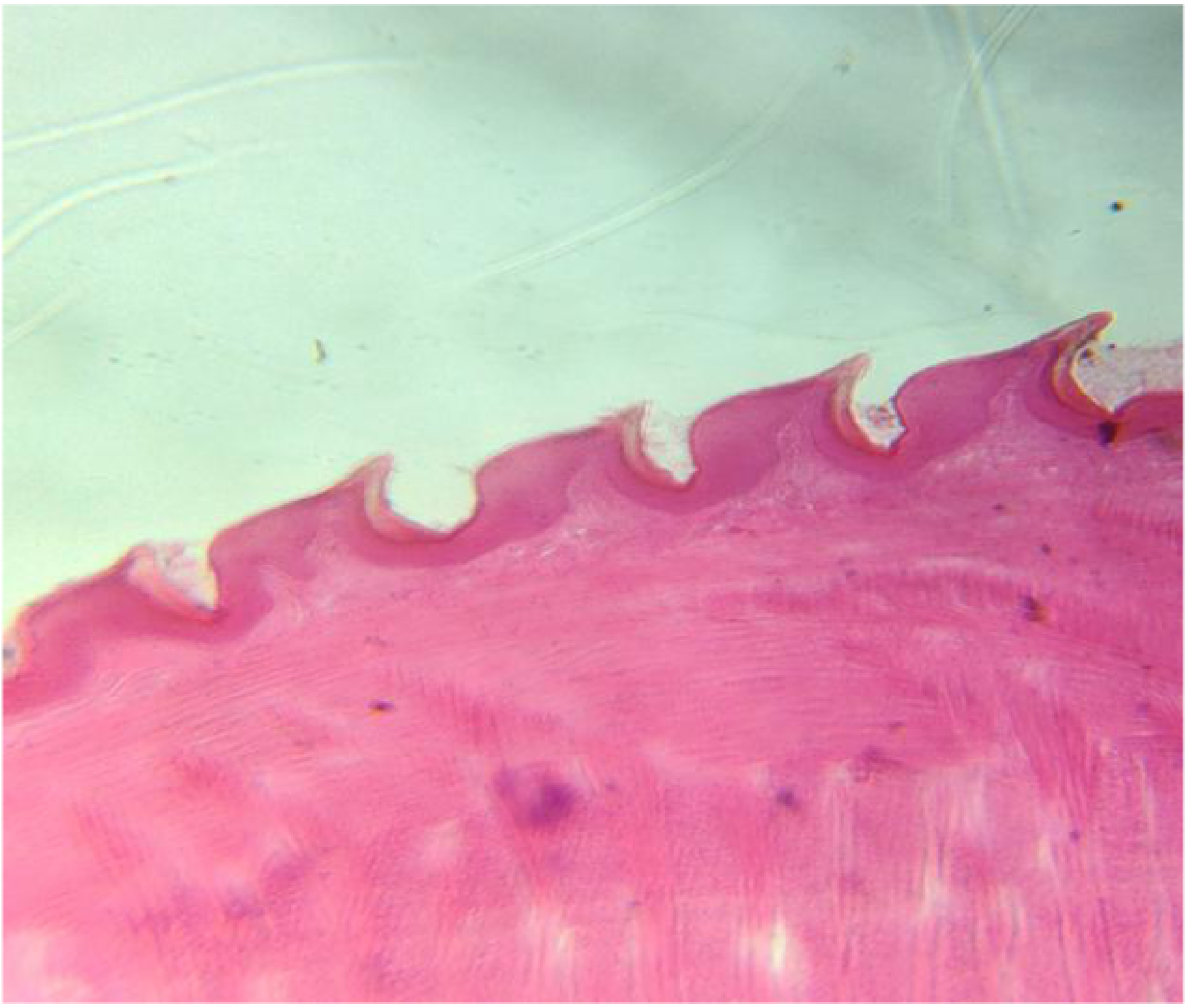

FIG. 4: Cat tongue 60×. Kenji Yoshino

The stand's size and durability also make it far better suited to field work than heavy and delicate light microscopes. And as nothing on the microscope stand costs more than a couple of dollars, it is easy to replace any parts if they are damaged. It also can be used to view objects that are not slides; it is only limited by what can fit on the specimen stage. Unlike light microscopes, this design can also facilitate the viewing of opaque items.

3. MATERIALS

Needed are the following (all dimensions are in inches):

Three 4½ × 5/16 carriage bolts
Nine 5/16 nuts
Two 5/16 wingnuts
Five 5/16 washers
One piece ¾ × 7 × 7 plywood for the base
One piece ⅛ × 7 × 7 Plexiglas for the camera stage
One piece ⅛ × 3 × 7 Plexiglas for the specimen stage
One piece ⅛ × 2 × 5 Plexiglas for the sample slide (two if using a second lens)
One piece scrap Plexiglas (~2 × 4) for the specimen slide (optional but useful)

- One laser pointer focus lens (use two for increased magnification)
- One LED click light (necessary only for viewing backlit specimens)

4. TOOLS

Needed are a drill, assorted bits, and a ruler.

FIG. 5: Materials for stand. Luke Saunders

5. PREPARATION

It only takes about $10 worth of materials and 20 min of time to build this microscope stand. First, remove the focus lens from the laser pointer. Start by unscrewing the housing and removing the batteries. The focus lens is right behind the nose cone. Using the back end of a pencil, push the inner assembly out the front of the housing. Unscrewing the plastic cap on the front of this assembly should free the lens.

Make a mark on the front two corners of the plywood base ¾ in. from both the sides and the front edges. Make another mark, centered on the board, ¾ in. from the bottom. Stack the Plexiglas camera stage on top of the plywood. Be sure to line up the edges. Offset the specimen stage so that it extends ¾ in. off the front of the base. When they are lined up, drill through all the pieces. In order for the microscope to sit flat, you will need to counterbore the bolt holes underneath the base.

After inserting the bolts, flip the base over and add a washer and nut to secure each of the bolts to the base. Drill a hole the same diameter as the lens in the camera stage, in line with the front two bolts.

To make sure the LED light is centered below the lens, use the hole you just drilled to mark the position of the light. Use a spade bit to create a recess for the light, but be sure not to drill all the way through the base.

Embed the lens in the camera stage by gently pressing it into the hole. Now you're ready to assemble.

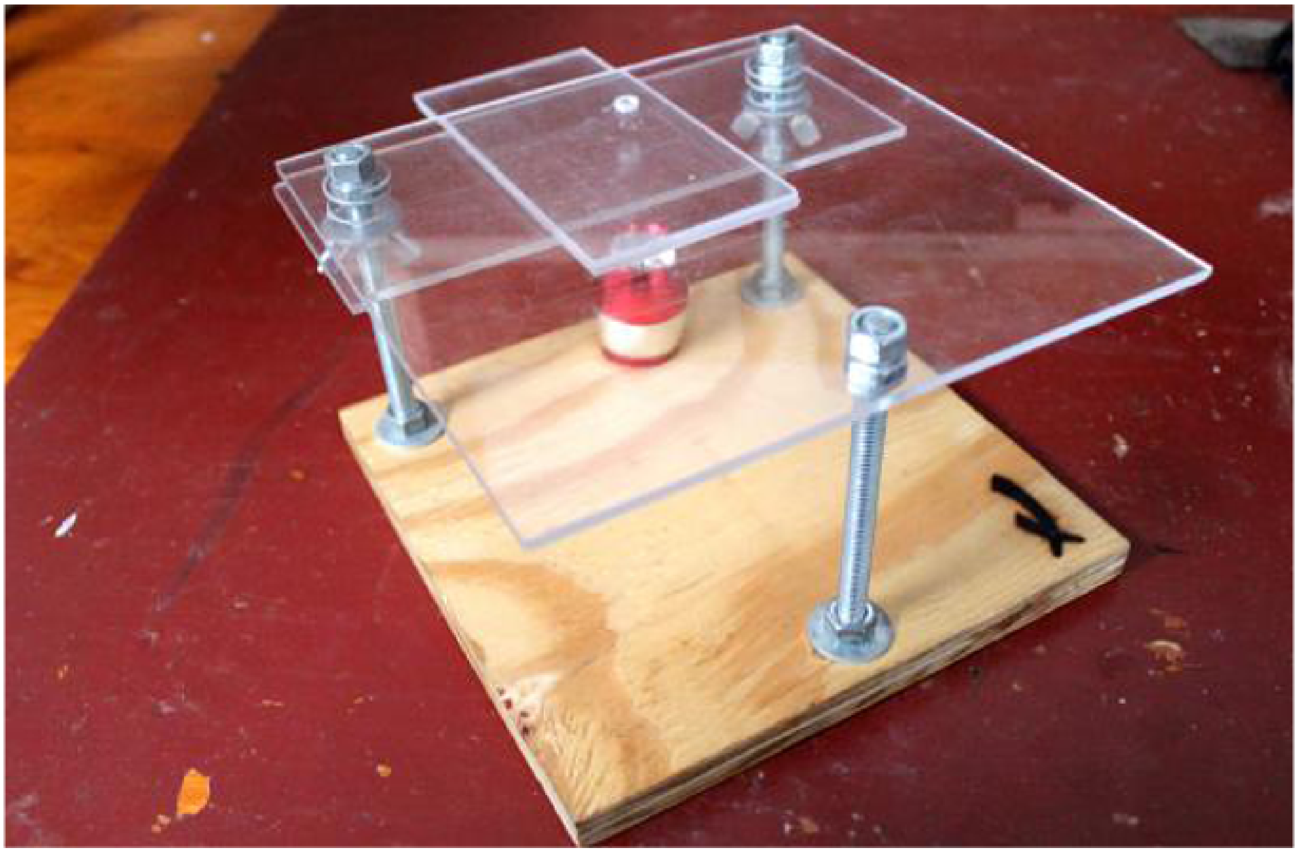

FIG. 6: Lens embedded in camera stage. Luke Saunders

Add the wingnuts, with the wings facing down, and washers to the front two bolts. Next add the specimen stage. Add a nut to each bolt and then place the camera stage on top. Before securing the stage in place, check to make sure it is level. Add and tighten the final three nuts, and place the LED light on the base, and the microscope stand is ready to use.

6. OPERATION

To operate the microscope, align your smartphone's or tablet's camera lens with the focus lens on the top of the stage. The easiest way to do this is to open the camera app and look at the screen as you lower your device. Place the object you would like to view on a Plexiglas sample slide and then place the slide on the adjustable specimen stage.

Bring the object into focus by slowly turning the wingnuts on either side, making sure you rotate both wingnuts in the same direction. Once the specimen is in focus, you can take a picture or video or use the digital zoom on your device to further increase the magnification.

The use of a Plexiglas sample slide is imperative for viewing anything thinner than a coin. The focal length of the lens is very short and the specimen stage can be raised close to it but not always close enough because of the nuts holding up the camera stage. Using a transparent slide fixes this issue and makes manipulating samples while viewing easier. With two lenses the focal length gets even smaller and two Plexiglas slides are required to focus.

7. ALTERATIONS

It is possible to stack two lenses in the camera stage. This has increased magnification to approximately 325×. I embedded one lens from the top and another from below. If attempting this set up, one should be careful not to let the lenses touch and to try to install them as level as possible. Failing to do so can cause aberrations in the image.

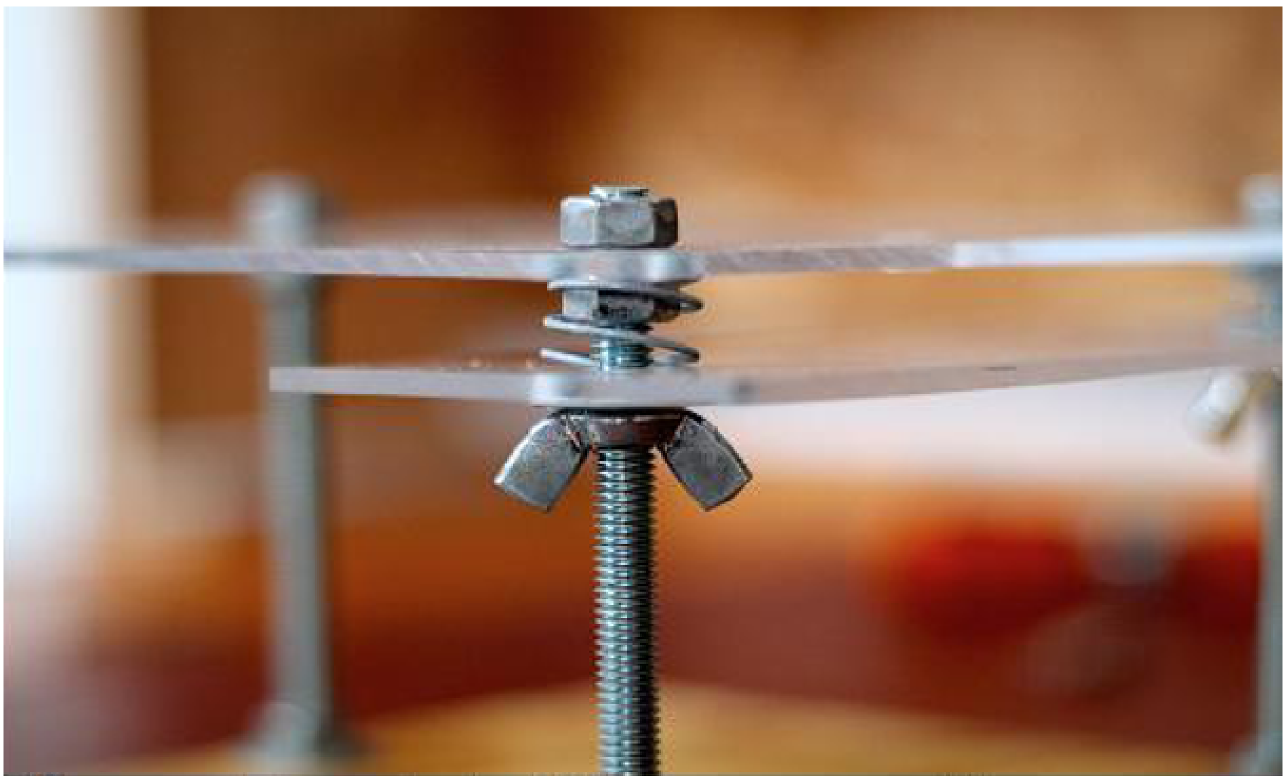

FIG. 7: Compression spring between camera and specimen stage. Luke Saunders

Mounting compression springs between the camera and specimen stages around the bolts keeps the specimen stage stabilized and allows for far finer adjustments with the wingnuts. Without the spring, the specimen stage could tilt one way or another if the load on the stage is imbalanced or if the holes to accept the bolts are too large.

8. OBSERVATIONS AND RESULTS

Since the release of the design in October 2013, the microscope has found its way into the hands of students, educators, scientists, and other professionals.

A teacher working on a master's in technological education in Brazil is conducting research on the microscope's use in schools that do not have a science lab and whose students do not have access to conventional microscopes. Another teacher in Chile is investigating the applications of this microscope in "vulnerable" schools to see how it aids hands-on science education. In the UK, a team of "science buskers" use the microscope as part of its interactive demonstrations at public events at Imperial College in London. They favored this microscope design because it allowed members of the public to use their phones and take something away from the project to show to others. Additionally, teachers in France, Argentina, and India, whose students did not previously have access to microscopes, used this microscope in their classrooms.

Naturally, the smartphone microscope has been adopted by science museums for science education outreach. The Science Center of Iowa and Arizona Science Center have both used the device to engage and educate their patrons about microscopy.

The microscope's DIY nature has also made it a favorite of community makerspaces such as Des Moines' Area 515. HiveBio, a community supported DIY biology laboratory in Seattle, Washington, has used the microscope extensively in its community workshops to further its aim of creating an accessible and affordable lab space for members to carry out research and experiments. In its first DIY Digital Microscope Workshop in November 2013, HiveBio invited community members to assemble and then use the microscopes to view a variety of samples. The smartphone microscope is also used in the organization's Introduction to Microscopy workshops and its workshops on model organisms.

Radical Mycology, a grassroots organization dedicated to educating individuals and communities and giving them the skills to cultivate mushrooms and other fungi, has recently adopted the microscope for field identification. Peter McCoy, the founder of Radical Mycology, uses his smartphone microscope to identify spores and other characteristics on the gills of fungi.

Outside of the field of education, other working professionals have found uses for the microscope. Less than a week after the instructions were published, an exterminator in the pest control business wrote in saying that he keeps the microscope stand in his truck for quick and easy identification of insects.

This smartphone-to-microscope conversion provides an alternative to expensive microscopes. Its design and features make it ideal for both formal and informal science education and it serves as a viable option for underfunded science classrooms that would not otherwise be able to perform experiments requiring a microscope.

9. SELECTED PUBLICATIONS

These include *Radical Mycology* by Peter McCoy, 2016 Edition, February 2016; forthcoming; *MAKE* magazine, March 2015; *Wired UK*, September 2014, *The Grinnell Magazine*, winter 2013; *Midi Libre*, July 2013; SocietyforScience.org; Instructables.com; Video.

ePortfolios and PLA

Hurley Betty, Streaming Editor

Welcome to this section on prior learning assessment (PLA) and ePortfolios. In this introductory paper, I present the major themes connected with these two areas, describe how they are interrelated, and then link to the three other papers in this first issue.

Abstract

The division between formal and informal learning is blurring. Terms such as emergent learning better describe a networked environment of resources and a learner's interaction with those resources in creative ways. ePortfolios provide a natural environment for documenting emergent learning, perhaps in preparation for gaining a credential for that learning.

KEYWORDS: ePortfolios, prior learning

Betty Hurley has a doctorate in math education from the University of Rochester. She has been at SUNY Empire State College for over 30 years and is currently a professor and area coordinator in mathematics, developing and teaching online math courses. She has coauthored a book, *Foundations of Learning*, and has recently been experimenting with ePortfolios for learning. She has developed some open educational resources, including a course called, A Mathematical Journey, available through Wikieducator, and a course on ePortfolios for STEM educators as an HP Fellow.

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1. WHERE TO BEGIN?

First of all, the term PLA, although still used widely, does not capture the breadth of approaches to credentialing learning used today. The "prior" in the term especially connects more with a time when separation between formal and informal education was clearer. Formal education, for my generation and many generations before me, meant learning that occurs in a classroom. It was learning that was assessed primarily through written tests. Informal learning, broadly defined, is learning that occurs elsewhere, whether through self-study or through participation in group activities such as after-school programs and special events. Note that the National Science Foundation (NSF) still tries to differentiate between these categories of learning (NSF, no date).

With the dramatic increase of resources on the Internet, the boundaries between formal and informal learning are losing their helpfulness in describing learning environments. The emerging terms are "emergent learning" and "prescribed learning" (Williams et al., 2011). According to the authors, prescribed learning is centrally determined, hierarchical, fixed, and predictable. Emergent learning, on the other hand, is unpredictable and arises out of the interaction between the learners and their context.

The "prior" in PLA is being challenged, because it implies that once someone begins participating in formal education, one ends other forms of learning. Thus, the institution of higher learning may develop a process to credential previous learning that may be college level, but then the opportunity for credentialing learning outside the institution ends. In many of institutions, PLA is also confined to learning that equates to what is found in that institution's curriculum. For example, someone with experience as a manager may be able to challenge the institution's course in introduction to management, most likely by taking the final exam for that course. The article by Scott Campbell from CAEL provides an approach to PLA that applies this new paradigm.

Challenges to the status quo in higher education are not confined to pedagogical terms, however. We cannot forget the financial aspects. The horror at the amount of student loans and how these weighty loans are affecting the futures of graduates laden with them is increasing. The push now is to make higher education more affordable. The ability for a learner to credential emergent learning is the next frontier for the credentialing of learning.

Badges are evidence of this move to credential learning outside of the institution. But higher education is also heeding the call for radical change. The Gates Foundation has been providing large grants to institutions that create alternatives to traditional classroom-based learning and grading. The traditional credit hour is being challenged as a measure of learning. And American Council on Education (ACE), with a grant from the Gates Foundation, has launched an Alternative Credit Project involving 40 institutions accepting the credentialing of learning from organizations such as EdX, Ed4Online, Jumpcourse, and Saylor (ACE, no date)

Other organizations have been working at developing frameworks to assess emergent learning. Association of American Colleges & Universities (AAC&U) has developed VALUE (valid assessment of learning in Undergraduate education) rubrics to assess the achievement of essential learning outcomes for a twenty-first century learner (AAC&U, no date). These include communication skills as well as creative thinking, teamwork, and integrative thinking. The Lumina Foundation has as a primary goal alternative credentialing and has created a DQP (degree qualifications profile) as part of that project (LF, no date). The Lumina Foundation also provided a grant to SUNY Empire State College, which has been disseminating a GDQP (global degree qualifications framework). This framework was specifically developed to assess emergent learning (Global Learning Qualifications Framework, 2013).

Swirling around all of this is the construct of competencies. Rather than believing that taking 40 separate courses really leads to the development of skills needed to not only survive, but even prosper in this century, why are we not assessing learners' core skills and their ability to apply them?

2. ePortfolios?

Enter ePortfolios. At a recent Association for Authentic, Experiential, and Evidence-Based Learning conference, several suggested getting rid of the "e," since the "e" can almost be assumed, given the expectation of electronic versions of almost everything. I will continue to use the term ePortfolio but agree that the "e" is superfluous.

Helen Barrett is known as the "grandmother" of ePortfolios. She has been advocating ePortfolios for many years, and her Web page is full of helpful resources. Her TED talk (Barrett, 2010) is inspirational—one that moves viewers away from conceiving an ePortfolio as merely a depository. For her, an ePortfolio becomes the center of one's emergent learning. From one's ePortfolio space, a learner reaches out to resources, including Internet resources and also humans. Yes, this space documents that journey. But, it also includes reflection by the learner about the artifacts in the ePortfolio. In addition, in the organizing of that space, the learner is taking ownership of his or her learning journey.

Because of the perfect correlation with emergent learning (learner controlled, unpredictable, collaborative), the ePortfolio is an ideal environment to document emergent learning for credentialing purposes. In order to credential learning, the learner needs to make that learning visible to the evaluator. If the learner is documenting that learning as it occurs through the ePortfolio environment, that visible proof will then be available to the evaluator.

Shane Sutherland, president of PebblePad, an innovative ePortfolio system, uses the term ABLE (activity-based learning environment) to describe what can happen in an ePortfolio environment. Shane identifies two types of portfolios, namely, *task* and *about me*. Task portfolios focus on a project, such as an independent study, team project, research project, documentation of a field trip, or internship. About-me portfolios provide information about the learner, e.g., his or her attributes, competencies, achievements.

The term "employability" was discussed many times at the AAEEBL conference. Certainly, the development of a portfolio as part of one's application for employment is a potentially high motivator for many students. A new ePortfolio provider, Seelio, builds on that motivation with a direct connection to potential employers. (More information about Seelio and other providers is available in the Web version of this journal.)

A different approach to ePortfolios was taken by Elaine Gray of Appalachian University. Gray, author of the book, *Conscious Choices: A Model for Self-Directed Learning*, discussed the method of contemplative pedagogy for empowering and situating the student's sense of purpose as they initiate their ePortfolio designs. She refers to this as a strategy of living questions to help students make meaning out of their studies at college.

ePortfolio systems have been used for many different applications. Recently, David Eddy of Sheffield Hallam University used PebblePad to deliver a MOOC to health professionals interested in enhancing prostate cancer care. PebblePad workbooks were used to deliver content. Participants engaged in discussions through PebblePad as well as through tweetchats. There were over 900 participants in the MOOC. In a remarkable use of ePortfolios, a university system in Chile, called DuocUC, instituted the use of ePortfolios as a final assessment in a competency-based program. Since 2012, 83,000 students have developed their ePortfolios for assessment. Improvements are needed, but the mere number is impressive.

3. NEXT STEPS

With each issue that this stream represents, my plan is to present some specific examples. In addition, in the Web version, I will provide links to resources, such as support groups for ePortfolio users and platform providers. If you would like to have a resource and/or application highlighted, please let me know.

For this initial issue, I have included a piece that looks at the broader issues, "From "MyWork" to "Our Work": A Return to the Mission of Higher Education," by Terrel Rhodes of the Association of American Colleges and Universities (AAC&U). Dr. Rhodes is currently Vice President for AAC&U where he focuses on the quality of undergraduate education, access, general education, and assessment of student learning. He is also director of the annual General Education Institute at AAC&U. He has been a primary force behind the VALUE rubric project mentioned earlier. In this article, he challenges higher education to move toward more learner-centered environments. He provides solid evidence of a disconnect between employer expectations and faculty claims of achievements of college graduates. He then provides some recommendations for how educational institutions can better facilitate deep, connected learning (through ePortfolios) and assess that learning more holistically (via using rubrics such as the VALUE rubrics.)

In the next issue, Bill Heinrich, an assessment specialist at MSU Global, and Jeno Rivera, a faculty innovation faculty at MSU Global, will discuss an innovative method for assessing learning in their article, "*A method for assessing experiential learning for ePortfolios*."

And, to look at the PLA side, Scott Campbell, Vice President, Higher Education Council for Adult and Experiential Learning (CAEL), has provided the article, "Portfolio Assessment Bridges the Employment Gap for Healthcare: Certified Workers Save Time and Money and Meet the Industry's Growing Need for Qualified Workers." This article provides information about a project whereby health workers can document learning from job experiences through an ePortfolio process.

Clearly, this introduction and the three papers have barely scraped the surface of these two areas. I look forward to exploring prior learning assessment (or perhaps emergent learning assessment) and portfolios with you in upcoming issues.

REFERENCES

ACE, Alternative Credit Project Resource Guide, (n.d.), American Council on Education; http://www.acenet.edu/news-room/Pages/Alternative-Credit-Project-Resource-Guide.aspx.

AAC&U, Value Rubric Development Project, (n.d.), Association of American Colleges and Universities; https://www.aacu.org/value/rubrics.

Barrett, H., TEDxASB Helen Barrett, February 25, 2010; https://www.youtube.com/watch?v=ckcSegrwjkA.

Global Learning Qualifications Framework, Retrieved from http://www.wcet.wiche.edu/wcet/docs/summit/GLQF-1pager4-29-14.pdf, 2013.

LF, Degree Qualifications Profile, (n.d.), Lumina Foundation; http://degreeprofile.org/.

NSF, Research on Learning in Formal and Informal Settings (DRL), National Science Foundation; https://www.nsf.gov/ehr/drl/about.jsp.

Williams, R., Karasou, R., and Mackness, J., Emergent Learning and Learning Ecologies in Web 2.0, *Intl. Rev. Res. Open Distrib. Learning*, March, 2011; http://www.irrodl.org/index.php/irrodl/article/view/883/1686.

WELCOME FROM THE EDITORS

Don Spicer

Frank Mayadas

John R. Bourne

Editors, *International Journal on Innovation in Online Education*

Abstract

The editors-in-chief of this journal provide a welcome to our new journal, *International Journal on Innovations in Online Education* (IJIOE). The background of each editor is also provided.

KEY WORDS: welcome

John R. Bourne was the chief innovation officer emeritus of American Sentinel University. Previously he was founding executive director of the Sloan Consortium, professor of electrical and computer engineering at the Franklin W. Olin College of Engineering, and professor of technology entrepreneurship at Babson College. He was also professor of electrical and computer engineering and professor of biomedical engineering at Vanderbilt University. He was editor-in-chief of the *Critical Reviews in Biomedical Engineering* for 27 years and editor of the *Journal of Asynchronous Learning Networks*. He was a founding faculty member of the Franklin W. Olin College of Engineering. He is the author of numerous papers and books, and holds a BE from Vanderbilt University and an MSE and PhD from the University of Florida. He is a Life Fellow of the Institute of Electrical and Electronics Engineers (IEEE). He has had sabbaticals at Northern Telecom and at Chalmers University in Gothenburg, Sweden. He received the Meritorious Achievement Award from the IEEE Educational Activities Board in 2003.

Donald Spicer is currently the associate vice chancellor for information technology and CIO for the University System of Maryland. In this capacity, he provides strategic direction and coordination for IT activities across the 12-institution system of public higher education in Maryland. Additionally, he has provided leadership in areas related to changing teaching and learning by effective use of technology. Previously, Spicer held CIO-level positions at Vanderbilt University and the University of Notre Dame. Prior to those positions, he held a senior position in IT administration at Dartmouth College. He has a BA and PhD (mathematics) from the University of Minnesota and a diploma in computer science from Corpus Christi College of Cambridge University. For the first half of his career, he was a faculty member in the mathematics departments at several prominent higher education institutions. Until recently, Spicer was an Educause Center for Applied Research Senior Fellow. In this capacity, he regularly published case studies and research bulletins related to noteworthy activities on the use of information technology in higher education.

Frank Mayadas was director of Anytime/Anyplace Learning at the Sloan Foundation, the principal philanthropy that has funded online learning at U.S. universities and colleges with more than $80 million over 17 years. He is also the founding president of Sloan-C, a consortium of more than 1500 academic institutions, offering more than 1000 degrees and certificates and tens of thousands of courses online. Prior to his work at Sloan, Mayadas was at IBM where he held key posts in research, technology, development, and other divisions. Toward the end of his career at IBM, he was secretary of IBM's Corporate Management Board and eventually director of the acclaimed Almaden Research Center. Recipient of the Irving Award, the highest recognition from the American Distance Education Consortium, he has also been honored as a member of the International and Continuing Education Hall of Fame. He is a member of the American Physical Society and Fellow of the IEEE. Mayadas received his BS in Engineering from the Colorado School of Mines and his PhD in applied physics from Cornell University. He has published widely in solid state physics, computers and systems, and online learning.

INTRODUCTION

Don Spicer, Frank Mayadas, and John Bourne welcome you to this inaugural issue of the *International Journal on Innovations in Online Education*. This issue has been in the making for nearly a year. We have recruited stream editors, talked to hundreds of people, analyzed areas of interest, and are starting this first issue with papers about analytics, immersive online education, online laboratories, the influence of social media on online education, ePortfolios, and innovations in nursing online education. The journal is modeled on the idea of streams; that is, flowing ideas about new occurrences and ideas in online education, overseen by a stream editor expert for each. We will visit many different streams over time as this journal is published. The first set of streams is listed below, along with the initial editors for each stream. You may think of streams as continuously changing focus areas that flow from issue to issue.

STREAM EDITORS

- Immersive Education—John Lester, Wiggle Planet, Inc.; on leave until 2016
- Analytics—Ananda Gunawardena, Princeton University and Carnegie Mellon University
- Online Laboratories, Crowd-Sourced and Citizen Science—Devon Cancilla, University of Missouri, Kansas City
- ePortfolios and Prior Learning—Betty Hurley, Empire State University
- Nursing—Eileen Thomas, American Sentinel University
- GIS—Jennifer Swift, University of Southern California
- Competency-Based Online Education—Shelley Howell, American Sentinel University
- Startups in Online Education—Linda Nelson, Board of Directors, Tech Fort Worth
- The Influence of Social Media on Online Education—Antonio Moreira, Coimbra University, Portugal, and Angelica Monteiro, Associate Stream Editor, University of Porto, Portugal
- Online Music Education—Carol Johnson, Werklund School of Education, University of Calgary

Each of these editors has exciting things to bring to you. And if you have something new and innovative in any area relevant to online education, let a stream editor or an editor-in-chief know.

The advisory board members of the journal are as follows:

- Kathleen S. Ives, DM, Chief Executive Officer and Executive Director at the Online Learning Consortium
- Richard Oliver, PhD, CEO, American Sentinel University
- Jack Wilson, PhD, President-Emeritus and Distinguished Professor at University of Massachusetts
- Robbie K. Melton, PhD, Associate Vice Chancellor. Tennessee Board of Regents
- John Lester, PhD, Wiggle Planet, Inc.
- Devon Cancilla, PhD, Vice Provost for Online and Distance Learning, University of Missouri, Kansas City

- Ananda Gunawardena, PhD, Professor at CMU and Princeton University and founder, TextCentric, Inc.
- Charles Thomas, Executive Director, USMAI Library Consortium
- Vijay Kumar, EdD, Senior Strategic Advisor, Digital Learning, MIT
- Richard Larson, PhD, Mitsui Professor of Engineering Systems, MIT
- Mark Milliron, PhD, Co-Founder and Chief Learning Officer, Civitas Learning, Inc.

A loose focus of the journal is on science technology, engineering, and mathematics (STEM) and STEAM (which includes arts), as well as health-care-related areas. But we are predominantly focused on innovation, so we will publish materials about innovations in online education, no matter what discipline they come from. We have incorporated innovations in the arts online into our work and will be initially examining innovations in music education online. We will look both for short papers that can appear on the website and longer papers that can appear in the online journal in PDF format. The length of a paper can vary, depending on the materials, but will often be about 10 pages, including figures and references. Of course, longer and shorter papers can be accommodated as appropriate.

You will note that we have included disciplines in our stream mix, because it is our intention to begin to explore online education within specific disciplines in our focus areas. These stream areas represent disciplines with high interest for online learning individuals and institutions. We intend to expand throughout the sciences, engineering, medicine, and the arts.

Although we are initially focusing on topics related to postsecondary online education, we will also publish innovative work in secondary education—again, the focus is on innovation in online education, no matter where it occurs.

AIM

The aim of IJIOE is to provide the field of online higher education with quality knowledge about what is going on in important areas of the field, with a specific emphasis on what is new and likely to affect it. IJIOE aspires to be the purveyor of ideas and expertise about the field, providing short papers, discussions with author experts, and reviews of methods for moving the field forward in selected areas.

RELATED ACTIVITITIES

As the journal develops, we intend to provide webinars and artificially intelligent bots that can answer questions about papers (from knowledge acquired from authors). Thus, we expect our journal to include innovations in publishing.

PAPER OVERVIEW FOR THIS ISSUE

This issue contains papers from six of the streams listed. Other streams will be available in later issues. The stream topics are analytics (a review of the current state of analytics for education written by the stream editor, Ananda Gunawardena), nursing (a review of an immersion experience in community health for nursing students), ePortfolios (three papers about mission of ePortfolios, prior learning, and experiential learning), immersive education (an paper about active learning in a disaster-themed scenario), social media (an paper about using MOOC for professional development of online faculty), and online laboratories (one paper about laboratory redesign and a second practical do-it-yourself paper on the website about making science accessible).

Please see each stream on this website for an abstract of each paper and a link to the full paper.

EDITOR'S COMMENTARY

The experience of starting this journal has been interesting. From the start, we had little idea about who would step up and want to provide information about the innovations in online education that they have been working on. As it turned out, many exciting things have come to our attention, some quite unexpected. One finding was that indeed there are many interesting things going on across the world. Another was that findings in widely separated disciplines are likely to cross-pollinate thinking in other disciplines. Hence, the idea of an international interdisciplinary journal is likely to be useful in ways that we had not completely anticipated. We hope that you will read the papers in the various streams and ponder how what you read will help in your own endeavors.

Frank Mayadas, former program director at the Sloan Foundation, provides a short separate paper overview that addresses the importance of innovation in online education.

Enjoy your time with us.

John Bourne, PhD, Editor-in-Chief

Don Spicer, PhD, Co-Editor-in-Chief

Frank Mayadas, PhD, Co-Editor-in-Chief

A New Journal? Why?

Frank Mayadas, PhD, Co-Editor-In-Chief

Abstract

This article addresses the question of why a new journal about innovations in online education has been started.

KEY WORDS: journal innovations streams pillars

You are reading the inaugural version of the International Journal on Innovations in Online Education (IJIOE). The editors hope you will find the papers useful and thought provoking. Most particularly, we hope you find content here that describes recent important innovations in online and blended education, some of which will be timely and necessary for your work.

Our field, the field of online education, is young, dating back roughly to the start of the commercial Internet (i.e., to about 1993). After an initial period, during which online education was practiced primarily in one model (over the approximate time interval 1993–2010)[1], online education has now scattered into a multimodal form. The preponderance of degree-oriented education is still largely available in the format initially developed and refined in subsequent years, but now we also have assorted other options, such as multiple MOOC models, Khan Academy, and similar variations.

Thus, our field is young and being practiced in many forms, with expectations of additional proliferation. This landscape is fertile ground for innovation, and this journal intends to be the primary catchment of these innovations. We need your input to make it as useful as it possibly can be.

The phrase “innovations in online education” is rather broad, indeed all encompassing, and we are applying it to a field with proliferating practice models. An organizing framework is needed, and the editors have arrived at a plan to ensure that each issue is a composite of papers representing several categories of current importance in the online education field. These categories or “streams” flow into each issue. Each paper submitted for publication is assigned to one of 10 streams currently identified and in use, and it is then assigned to a stream editor for examination and recommendation. This process intends to assure that we are directing special attention toward the important segments of this active field for innovations.

However, we additionally want to measure, as best as possible, how the innovations identifie dare leading to advancing overall quality in online (and blended) education. For this reason, we propose to align the papers being published in IJIOE with the Pillars approach to quality measurement. The editors will have a short section in each issue that shows how the papers published to date are distributed among the Pillars, which are access, learning effectiveness, faculty satisfaction, cost effectiveness, and overall student satisfaction[2]. This editor's section will show cumulative data so that we can all see where, among the Pillars, the majority of innovation is taking place and possibly where additional focus is necessary[3].

Periodically, the editors will also include at least a qualitative assessment of impact on quality from innovations described in IJIOE. As a general guideline, the editors will not accept untested innovations or armchair theorizing, but rather innovations that have been reduced to a degree of practice. In this way, we anticipate that impacts on quality will be visible.

Finally, I want to remind the readers and contributors that this journal is for you and for the larger online education community. We will always welcome your ideas and suggestions on all aspects of the publication and take actions to improve our service wherever possible.

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[1]During the 1993–2012 period, degree-oriented online education almost exclusively consisted of instructor-led courses with 15–25 students per class; course materials and capability of interactions between students and faculty all available online; with traditional tuition and appropriate fees being applicable.

[2]http://onlinelearningconsortium.org/5-pillars/

[3]We recognize that more than one Pillar could apply to a paper and for that reason, one paper may be distributed among two or more of the relevant Pillars.

NURSING STREAM EDITOR COMMENTARY

Eileen C. Thomas Ph.D., RN

American Sentinel University, Aurora, Colorado

KEY WORDS: commentary

Eileen Thomas currently teaches nursing courses at a fully online university and has taught online for over a decade, across all levels of nursing at several large public universities and private for-profit institutes of higher education. She is certified in online teaching by the Online Learning Consortium (formally the Sloan Consortium). Her interest in community health, global health, and qualitative research led her to develop and teach various online community health nursing, global health, nursing research and evidence-based practice, mixed research methods, and reflective practice courses for undergraduate and graduate nursing students. Thomas recently developed an online course that integrates an immersive virtual learning environment used to teach undergraduate students community health nursing concepts and a Florence Nightingale hall in a virtual museum that incorporates interactive quizzes, voice-over scripts, and entry into a virtual Crimean War and virtual Nightingale Training School for nurses. She has worked in a variety of acute care and community health settings, such as surgical intensive care, home health, hospice, and school nursing. She completed a pilot study that addressed men's knowledge and awareness of breast cancer in men, and for over a decade, her program of research focused on racial/ethnic diverse men and women's cancer screening behaviors. Her publications, including papers coauthored with undergraduate and graduate nursing students, and nurses from Iran and South Korea, are available in a variety of professional journals, including the ***American Journal of Nursing, Journal of Nursing Administration, Journal of Community Health Nursing, Cancer Nursing, Journal of Nursing Scholarship, The Qualitative Report***, and ***Health Care for Women International***. Thomas has presented at national and international professional conferences and received several distinctions and awards, including the Chancellors' Diversity Recognition Award for Faculty Leadership, the Deans' Excellence in Teaching Award, and the Health Disparities Scholar Award from the National Institutes of Health Center on Minority Health and Health Disparities.

The *International Journal on Innovations in Online Education* editors are excited about the publication of this first issue. Each issue will include papers that address cutting-edge teaching strategies and innovations currently in use at institutes of higher education among online educators across a variety of professional disciplines. For those of you who may not be familiar with the term "stream" or "stream editor," our editors-in-chief explain it as follows: The concept of a stream is based on the idea of a rapidly flowing stream of knowledge about an area in online education. Stream editors select streams based on insights to the field, observed need, and reader interest.

I would like to introduce myself as the stream editor for nursing. In this issue, you will find information on how an immersive virtual environment was incorporated into an undergraduate community health nursing course to teach students how to conduct a windshield survey and other community health concepts.

Without delving too deeply into what is meant by innovation, nurses—the largest group of health-care professionals—are known for their creativity and spirit of innovation. Changes in patient populations and student demographics have compelled online nurse educators to search for creative and innovative strategies that address the needs of their students. With the Institute of Medicine's mandate to increase the number of bachelor-prepared nurses by 2020, more nontraditional students are returning to school. Todays' nursing students are typically working registered nurses for whom traditional methods of teaching may not meet their learning needs. Many nurses are enrolling in online programs that will allow the adult learner to seek a higher degree yet maintain their full-time working status. Innovation is central to the success of any endeavor and should be an integral part of institutes of higher education. Research has revealed that hospitals employing larger numbers of bachelor-prepared nurses have a decrease in mortality rates and improved patient outcomes. According to the American Association of Colleges of Nursing (AACN), education enhances both clinical competency and patient care. Nurse educators have a responsibility to develop and implement innovative tools and strategies that will prepare a strong generation of nurses that can meet the challenging needs of our rapidly changing health-care system.

Health-care boundaries and shrinking geographical borders, global infectious diseases, and an increase in the number of refugees and immigrant populations requiring specialized, culturally appropriate care are just a few trends that are changing the practice role of nurses. This makes it essential for nurse educators to develop a spirit of innovation that will empower the next generation of nurses to become cutting-edge practitioners and leaders.

According to the U.S. Department of Education, innovation is the spark of insight that leads a person to investigate an issue or phenomenon. That insight is usually shaped by an observation of what appears to be an "aha moment" that results in a creative and surprising new idea. Innovation is driven by a commitment to excellence and continuous improvement and is often based on curiosity and a willingness to take risks and test assumptions. Innovation requires questioning and challenging the status quo, recognizing opportunity, and taking advantage when opportunity knocks. We invite you to join us by sharing your journey and the journeys of other educators who have challenged the status quo. In the world of education, innovation comes in many forms. There are innovations in the way education systems are organized and managed, innovations in instructional techniques or delivery systems, and innovations in the way nurse educators prepare our future generation of professional nurses.

INTRODUCTION TO "THE INFLUENCE OF SOCIAL MEDIA ON ONLINE EDUCATION" STREAM

John Bourne, PhD

Editor-in-Chief

I am pleased to introduce you to Dr. Jose António Marques Moreira from the University of Coimbra, Coimbra, Portugal, and Dr. Angélica Monteiro from the University of Porto, Porto, Portugal. Moreira and Monteiro will be assuming the editing of this stream in 2016. Below are their backgrounds and plans for this stream

Jose António Marques Moreira earned a PhD in education in 2009 from the Faculty of Psychology and Educational Sciences, University of Coimbra. His master's degree in education and degree in art history were awarded to him from the same university, the latter of which was from the Faculty of Humanities.

Moreira's complementary training includes post-doctorate in educational technology and communication at the University of Coimbra, a master course in multimedia in the Faculty of Engineering, University of Porto, a training course for teachers in elearning at Open University, Portugal, and an advanced training course for teachers of higher education at the University of Aveiro, Portugal.

His scientific and academic activities include serving as a researcher at the Centre for 20th Century Interdisciplinary Studies of the University of Coimbra (CEIS 20), in the Group of Policies, Educational Organisations and Educational Dynamics (GRUPOEDE). Moreira's recent interest has been to articulate his research interests with those of the GRUPOEDE, focusing the attention on the idea of development. He has therefore been looking into ways of studying the educational policies and how the national education/training systems are organised, and also the different concepts, models and practices of teaching-learning and initial and continuing teacher training. In the course of the functions to which he has been assigned as teacher at Open University, an e-Learning and Distance Learning institution, he has engaged in development processes, seeking to relate his academic activities with scientific activities, which has resulted in various publications in the past few years. He has supervised several theses and dissertations in this area (http://www.degois.pt/visualizador/curriculum.jsp?key=4209642637939659).

He is member of the Editorial Board and Editor Responsible for the collection *Contemporary Educational Dynamics* published by White Books. He is a member of the Editorial Board of the *American Journal of Educational Research*. He is reviser in several scientific journals, such as *OpenPraxis*, edited by the *International Council for Open and Distance Education-ICDE*, the *American Journal of Educational Research*, the *Revista Brasileira de Informática na Educação* [Brazilian Journal of Informatics in Education], the *Revista CientΓfica de Educação a Distância- Paidei@* [the Scientific journal of Distance Learning-Paidei@], among others.

Angélica Monteiro holds a PhD in education and Masters in multimedia education from the University of Porto. She is a researcher at the Centre for Research in Education (CIIE), University of Porto, and a researcher at RECI and professor in the Department of Education at the Instituto Piaget. She has published many papers on the subject of b-learning in higher education.

INFLUENCE OF SOCIAL MEDIA ON ONLINE EDUCATION: A PROSPECTUS

In this issue, there is one paper in the social media stream, "MOOCs as an Innovative Pedagogical Design Laboratory," by Whitney Kilgore, University of North Texas. The paper discusses an innovation for training faculty using MOOCs. According to the paper's abtract, increased demand for online learning options coupled with the pace of the evolution of technology and pedagogy has necessitated growth in the quality and quantity of facilitation training for online faculty to support effective educational experiences. On the basis of data presented in a variety of reports on MOOCs, the participants tend to primarily be people with a master's degrees or higher; thus, it makes sense to use MOOCs as multi-institutional professional development for educators who teach online. These digital learning spaces can bring educators together to explore new pedagogical techniques that can have a positive impact on their teaching practice. This paper will explore one such course, Humanizing Online Instruction, which was designed to allow instructors to learn the principles of a community of inquiry while exploring the use of social media and asynchronous video to enhance presence (instructor, social, and cognitive) in online courses.

This stream will be examining the influence of social media on online education from a number of different viewpoints, including the following:

- Web 2.0 tools
- Online communities
- Virtual learning communities
- Social networks, including tools and analytics

- Interactive platforms for social learning in education
- Learning management systems
- Implement of theoretical constructs, including connectivism
- Practical methods for implementing social networking for online education

We anticipate looking at a wide variety of emerging topics that fall within in this list. There will be overlap with other streams, but in every case, the papers found in the social media stream will be about new and exciting things that we have uncovered from various corners of the globe. I hope you can join us and contribute materials.

IMMERSIVE EDUCATION STREAM

John E. Lester, Stream Editor – On Leave

By John Bourne, Editor-In-Chief

John Lester has been the Stream Editor for the Immersive Education Stream during the 2015 startup period for the journal. He is on a six-month leave and will return in 2016. I will introduce him to you here and comment on what the stream will cover.

Abstract

Introduction to "Immersive Education Stream"

KEY WORDS: Immersive Education

John E. Lester has a background in neuroscience research and enhancing educational experiences through immersive education. After an education at Massachusetts Institute of Technology, Université de Fribourg, and Boston University, he spent 12 years at Massachusetts General Hospital and Harvard. He then moved to become the Community Manager and Boston Operations Director for Education and Health Care at Linden Labs (a pioneer in 3D worlds). He was then Chief Learning Officer at Reaction Grid, Inc. He is currently Lead Technology Evangelist for Wiggle Planet, a company that creates a new kind of emotionally intelligent animated characters.

Papers in this Stream

One paper appearing in this issue is "Researching Declarative, Procedural, and Meta-Cognitive Knowledge through Active Learning in Disaster-Themed 3D Virtual Worlds," by Michael Vallance, Future University, Hokkaido, Japan.

Here's the abstract: This paper summarizes an educational researcher's approach to determining the impact of active learning in disaster-themed 3D virtual worlds. The goal of the project is to advance students' declarative, procedural, and meta-cognitive knowledge by implementing measurable robot-mediated interaction activities in 3D virtual worlds. Through the design and iterative development of unique active learning activities for authentic international collaboration, the participants are able to synergize engineering and science academic content with the learning processes. In addition, by actively participating in international 3D virtual tele-collaboration challenges, which include controlling basic robots within a simulated disaster zone, quantitative metrics of students' programming skills and psychometric assessment of declarative, procedural, and meta-cognitive knowledge can be measured. This will enable educators to quantify the impact of active learning.

Prospects for the Future

Immersive education encompasses many ways of providing students with immersive experiences in their learning activities, ranging from virtual worlds that provide alternate realities for learning to augmented realities that add new dimensions to the students' actual learning space. For online education, in particular, virtual reality experiences often provide ways of student learning about something that they cannot obtain in the real world. A clear example of this is the active learning experience activities discussed in the Vallance paper. We intend to secure papers about the use of virtual worlds and their use in online education in the continuing stream.

Other topics will include augmented realities, technologies for increasing student access to immersive education, and examination of implementations in various disciplines (an example of an implementation in nursing/community health is provided in this issue in the Nursing Stream). From a practical viewpoint, we hope to be able to consider various products as well as cost and accessibility concerns, with a major focus on improvements in learning effectiveness through the use of immersion.

We would be interested in hearing from you if you have innovations that we should know about. Contact John.R.Bourne@gmail.com or dspicer@usmd.edu if you would like to discuss what you are doing in this area.

WELCOME FROM THE STREAM EDITOR: LEARNING ANALYTICS IN ONLINE EDUCATION

Ananda Gunawardena, Ph.D

Stream Editor

Princeton University

Abstract

Analytics is the discovery and communication of meaningful patterns in data. Businesses have used analytics for years to improve their products and customer satisfaction. Now it is time for education to use analytics to improve teaching and learning. Analytics can also be used to improve the effectiveness and efficiency of delivery of educational content. In this editorial, we address some key areas of educational analytics.

KEY WORDS: analytics, privacy, institutions, students, teachers

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I am pleased to welcome you to the Stream on Analytics in our new journal, *International Journal on Innovations in Online Education*. In this inaugural issue, we explore the role of learning analytics in educational innovation. Analytics is the discovery and communication of meaningful patterns in data. As more and more technology is integrated into today's instruction from K–12 to higher education to continuing education, there is an unprecedented opportunity to use analytics to make learning more effective and efficient. This introductory paper explores the current state of the art in analytics-driven education and its potential as a revolutionary force to change the way we teach and learn. We will discuss several case studies on how analytics are used in multiple disciplines and will highlight some of their impact on K–12 and higher education. In future issues, we will discuss learning analytics standards, institutional use of learning analytics to reduce dropout rates, controlling cost of education with the help of analytics, and improving student learning using analytics.

Learning analytics can help revise curriculum, provide better teaching, and improve assessment in real time. More and more learning management systems will provide dashboards that can be used to get a snapshot of the state of a course. Systems like Purdue University–based Course Signals will alert instructors when a student is falling behind. The intelligent tutoring system-based platforms like Open Learning Initiative (OLI) will continue to guide the learners through a path based on what the system thinks is the next best thing to do to for the learner. Innovations in analytics in education will come from individual instructors who can now utilize modern tools (such as Classroom Salon, Edmodo, or Knewton) to design, deliver, and use the data to improve instructions. Sometimes, the interpretation of data at the macro level can be difficult. Therefore, third-party predictive analytics companies will provide services to educational institutions that are trying to interpret large collections of data. For example, in one recent study at American Sentinel University, the data predicted that if a student completes half the curriculum, they are 99% more likely to complete the degree. This is valuable data to the institution to minimize student dropouts by providing more support during their first half of study. There is no magic bullet in educational analytics. Creating a better learning environment and obtaining good outcomes is a complex task. When a student fails a course or doesn't submit an assignment or attend class, the reasons can be much more complex than just the educational data analytics. But educational analytics provide a way to "know" the status of the student without any formal assessments. Sometimes it is better to know than to measure. Formative assessments like tests and quizzes do not always tell the whole story. Instead student data must be available on a daily basis and in easy-to-understand visual formats so instructors can make real-time adjustments to their teaching techniques to maximize the course outcomes.

In flipped classes, the role of analytics becomes even more important. If the instructor knows which sections students are having trouble with, those concepts can be addressed in class more effectively. One key question that still must be addressed is the privacy of data. How can we balance privacy while using data to make good teaching decisions and help students navigate through courses? One other thing is clear. With the availability of platforms like Google, Wikipedia, and YouTube, we no longer understand how or when students really learn. Therefore, future educational systems must find ways to integrate with other data sources, such as Google, Wikipedia, and YouTube, to create a more global picture of the learner. All in all, we think that analytics-driven learning will dominate education in the coming years. It will allow faculty resources to be efficiently allocated to teaching and learning. Analytics can only create better outcomes in education, and we remain hopeful that analytics will significantly drive educational outcomes and reduce the cost of education.

In the future issues, we will address learning analytics standards, institutional use of analytics to reduce cost and reduce dropout rates, privacy issues when collecting vast amounts of data, and use of computational techniques such as machine learning to help interpret data and to discuss how individual instructors are utilizing learning analytics to help improve their teaching. We encourage educators to innovate on how they use analytics in their teaching. As you invent new ways to teach using analytics, submit a paper to me to be considered for a future issue.

MEET THE STREAM EDITOR

Ananda Gunawardena is a teaching faculty member in the Department of Computer Science at Princeton University. He served as an Associate Teaching Professor of Computer Science at Carnegie Mellon University (CMU) from 1998 to 2013 and is currently a adjunct faculty member at CMU. He is a longtime advocate of technology in education and the application of the principles of learning sciences to teaching and learning. He is the co-author of two college textbooks in computational linear algebra published by Springer-Verlag and Thompson Brooks-Cole and is the author and co-author of over 35 research articles. His textbooks have been translated into other languages. He is the co-creator of Classroom Salon, a platform to increase student engagement through annotations and analytics. He has received funding from NSF, Qatar Foundation, Hewlett Packard, Microsoft, Google, and many other foundations. His many honors include leadership in technology award from HP, service award from Jesse Jones Institute, ACM Appreciation Award from ACM Houston chapter, and Exceptional Achievement Award (highest honor given to Sri Lankan expatriate) from the Sri Lanka Foundation. He was a founding fellow of HP Catalyst Institute in 2010. From 2010 to 2013, he co-led the HP's measuring learning consortium, a multimillion-dollar effort to introduce data-driven learning. He is currently the Stream Editor for learning analytics at the *International Journal on Innovations in Online Education*. He typically teaches courses in algorithms, data structures, systems programming, and pen and mobile computing. His research interests include technology in education, learning sciences, and HCI.

ONLINE MUSIC EDUCATION STREAM INTRODUCTION

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KEY WORDS: online music, introduction

Online music has become a part of our culture. The sheer volume of iTunes songs, learn-to-play guitar tutorials on Youtube.com, and apps like SoundTrap.com for making music across the Internet tells us that our culture still has a musical mooring. But how is our postsecondary educational culture changing with the high level of technologies available for music, and consequently, music learning? The Online Music Education stream portion of the *International Journal on Innovations in Online Learning* seeks to provide some answers to that large, yet focused question.

Over the course of our volumes, we will take time to highlight some of the interesting ideas and research that are taking place across the globe with regard to the use of the online learning platform for teaching music.

This stream, while focused on postsecondary music and music education, will look at exploring the innovative ways that faculty are transforming their traditional music teaching pedagogy to the online platform. This may seem like an easy task, but let us briefly consider the philosophical connections of apprenticeship, mentoring, and the artistic nature of music itself. The educational foundation of music learning is based on a direct student-to-master teacher experience. So, how is it that music can be learned in an online platform? That is what we will be discovering through our journey.

Scholars continue to debate the importance of technology as the vehicle for learning (Clark, 1983, 1985) and the necessity of the medium (Kozma, 1991, 1994). Yet it is clear that music education has adopted technologies across the centuries (de Vaney and Butler, 1996) to be both culturally relevant and focused on meaningful learning. Looking at the current kaleidoscope of formal online music learning, we have MOOC music course offerings from the University of Rochester, fully online bachelor's degree programs such as Valley City State University and Berklee Online, and various online courses offered at institutions around the world. Although a quick Web search can locate universities with online music courses or programs, deeper learning questions surface: How is music being taught online? What technologies create a meaningful music learning experience for students? What are essential teaching components that create a motivational learning experience for music students? These questions become more and more focused as we seek to understand the intricacies that are held within teaching an artistic discipline within an online context.

Beginning with Issue 2 of *International Journal on Innovations in Online Education*, we will start our journey into exploring the landscape of online music learning. Our first paper will present three aspects of online music learning. First, it identifies informal and formal ways for learning music online. To better position our understanding of the impact of online learning in music education, the second part of the paper evidences the exponential rate of increase of online music course offerings for undergraduate students. Finally, to provide a referential frame through the eyes of STEAM, the paper identifies the connection of online music learning to academic disciplines, such as physics, at the undergraduate level. Filled with examples of websites you can use to extend your own research knowledge, this paper provides a springboard toward our learning into online music education.

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We hope to hear your comments about our new stream and look forward to new submissions throughout the year.

REFERENCES

Clark, R., Reconsidering Research on Learning from Media, *Rev. Educ. Res.*, vol. **53**, no. 4, pp. 445–459, 1983.

Clark, R., Evidence for Confounding in Computer-Based Instruction Studies, *Educ. Commun. Technol. J.*, vol. **33**, no. 4, pp. 249–262, 1985.

de Vaney, A. and Butler, R., Voices of the Founders: Early Discourse in Educational Technology, Jonassen, D. H. (ed.), *Handbook of Research for Educational Communications and Technology: A Project of the Association for Educational Communications and Technology*, Macmillan Library Reference, 1996; http://www.aect.org/edtech/ed1/pdf/01.pdf.

Kozma, R., Learning with Media, *Rev. of Edu. Res.*, vol. **61**, no. 2, pp. 179–211, 1991.

Kozma, R., Will Media Influence Learning? Reframing the Debate, *Educ. Technol. Res. Dev.*, vol. **42**, no. 2, pp. 7–19, 1994.