Why IT Matters to Higher Education

EDUCAUSE review

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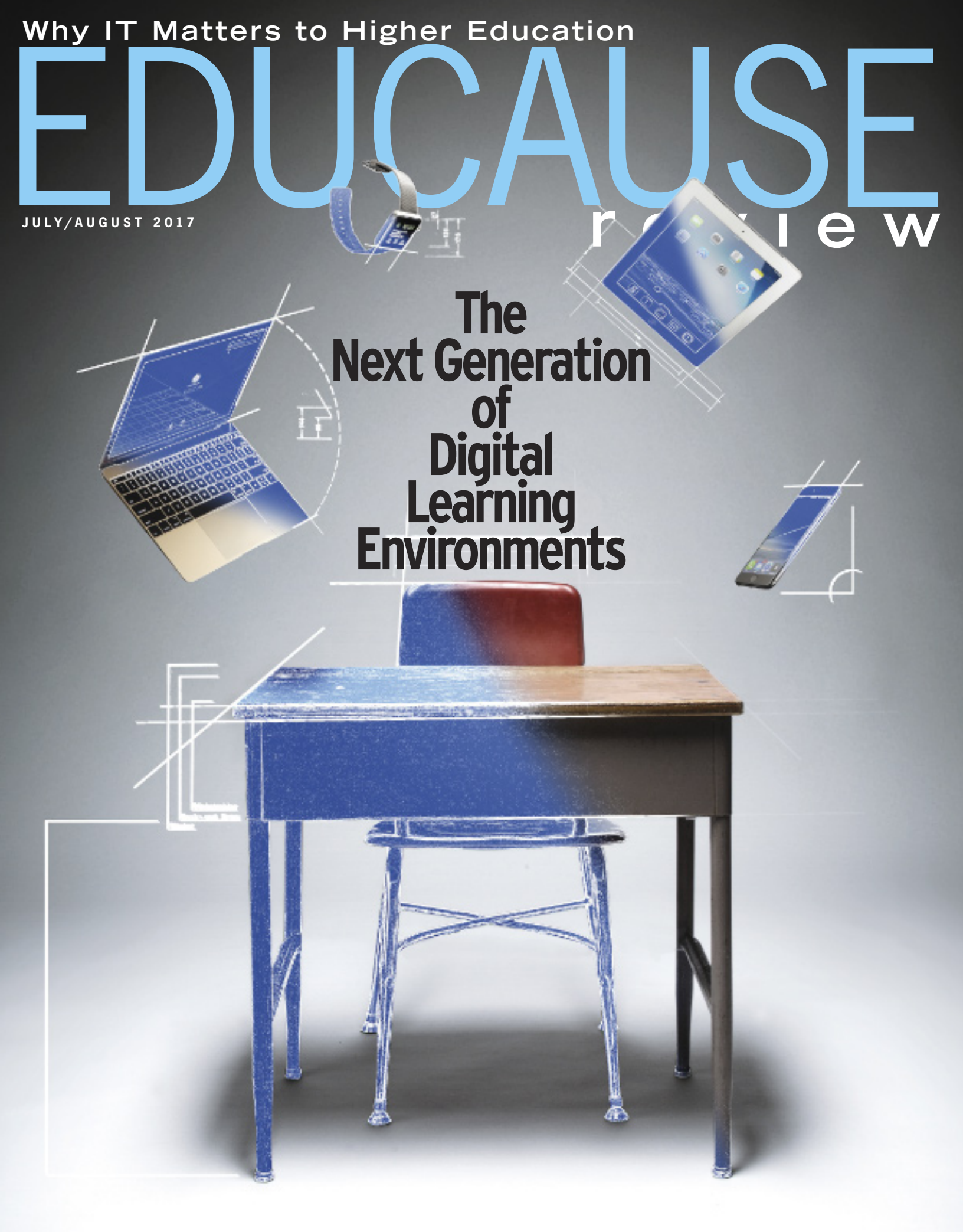

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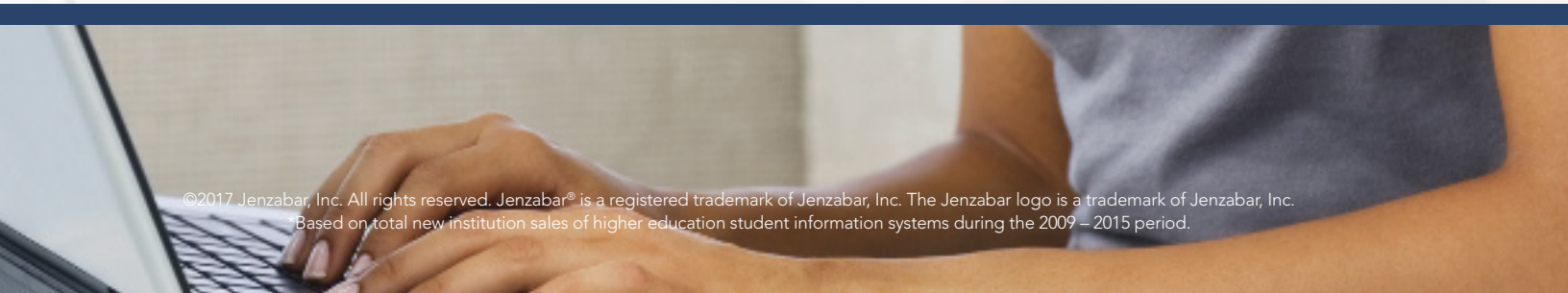

*Based on total new institution sales of higher education student information systems during the 2009 – 2015 period.

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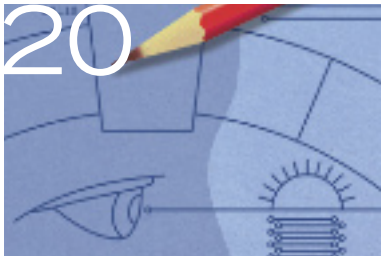
JULY/AUGUST 2017 VOLUME 52, NUMBER 4

FEATURES



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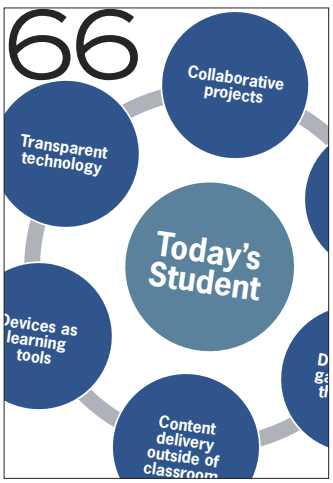

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By JOHN O'BRIEN

Next Steps for the NGDLE

Since April 2015, when the original EDUCAUSE report on the next generation digital learning environment (NGDLE) was published, the idea has decidedly taken off. I believe we are still talking about the NGDLE two years later because the framework captures the imagination without limiting the scope of what the next generation environment could be. In fact, the universe of future environments has expanded since 2015 as various elements of next generation environments (e.g., analytics, adaptive learning, and social networking) have grown—both in number and complexity. The power of the NGDLE is its richness, not its specificity, as the wide-ranging articles in this issue of *EDUCAUSE Review* make clear.

In his framing essay, Malcolm Brown effectively reviews the genealogy of the NGDLE. More importantly, he paints a compelling picture of its constituent parts, finishing with a strong appeal to agency. In the end, the NGDLE will be defined by us because, in Brown's words, "we are the architects." Appropriately, his final appeal is to the EDUCAUSE community to continue the conversation that this unwieldy acronym began.

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Joining this conversation are Phillip D. Long and Jon Mott, with an article on what they call "N²GDLE" (just when you thought an acronym couldn't get any more ungainly). They see the roots of the NGDLE in the aspirational dreams of "intelligent tutoring systems" that harken back to the 1960s and 1970s. These systems were, the authors say, unable to transform higher education to become more student-centered. Similarly, they note that we have developed contemporary systems that pretty much continue traditional teaching and learning roles. They write: "If we are content with the status quo, we can simply stand pat with the tools, processes, and role definitions that structure teaching and learning at our higher education institutions today." Or, as an alternative, Long and Mott offer an "aggressive and aspirational vision of the N²GDLE," which integrates the best of networked and adaptive learning environments. They outline in detail the environment's components, all of which they believe are within reach.

Stephen Laster, chief digital officer for McGraw-Hill Education, shares this focus on a learning environment that will be student-centered. He too supports the vision of the NGDLE, with a particular focus on the development and widespread adoption of interoperability standards. His article, "Tearing Down Walls to Deliver on the Promise of Edtech," is not only a powerful endorsement but also an encouragement to college and university leaders to keep the pressure up. He writes: "The true accelerator toward the NGDLE's world of choice is the virtuous cycle of institutions and faculty demanding the implementation of standards in their procurements of edtech and the commitment of edtech vendors doing their best work to make standards-based integration a core capability of their offerings."

Michael Feldstein's article, "What Is the Next-Generation?," offers an extraordinarily sweeping but concise history of the learning management system (LMS). According to his LMS family tree, the current LMS is third-generation, which started around 2010, "when moving from one LMS to another became easier, class spaces within the LMS became easier to populate with specialty tools for particular kinds of educational interactions, and ease of use began to improve significantly." Looking ahead, Feldstein identifies the catalyst for the fourth

(continued on page 6)

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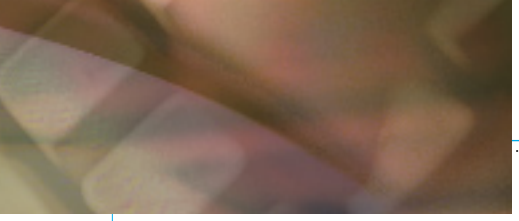

(continued from page 4)

generation: "All of the pieces—the products and the interoperability standards, the educator demand, and the institutional procurement processes—have to come together in order to drive a step-function change." Feldstein insists that this next generation of digital learning environments will not be realized at conference sessions or in published articles. Rather, it will emerge from the "boring and obscure" work that is needed for real change—work that takes place "in deeply unsexy places like technical interoperability standards meetings or on LMS selection committees."

There are many recurring themes in the NGDLE articles presented in this issue of *EDUCAUSE Review,* along with multiple understandings of where the NGDLE came from and where it may be going. In "The Origins of Innovation in the Edtech Ecosystem," Vince Kellen notes that discussions like these often ignore the essential pliability of technology tools. He offers a wide-ranging, compelling analysis of hope and hype, but he concludes that seeing information technology merely as a disruptive tool misses out on the far more urgent, far more lasting results that come from seeing IT tools and the people who wield them evolving together. In this vision, the LMS is replaced by a market in which "both tools and tool-makers undergo intertwined incremental evolution to help solve local and collective problems." Kellen concludes with a call to action for his fellow CIOs.

D2L CEO John Baker offers his unapologetic conviction that the evolution of the LMS is the best expression of the NGDLE: "We cannot leave it to instructors to be LMS, content, and pedagogical experts. We need to give them a ready-made—but flexible—system." Baker is also skeptical of the metaphor of "old school" Legos used in the 2015 EDUCAUSE white paper: "Modern edtech is a lot more like the modern Lego. There are wheels and rocket launchers and belts and all kinds of amazing pieces that work well with each other, but only when they are configured properly. A user cannot simply stick together different pieces and assume they will work harmoniously." Baker proposes an additional metaphor, of the LMS as a connecting central nervous system. Focusing on what people need rather than what technology can do, Baker issues a call for the vendor community to be "better partners" who will contribute to a "next generation LMS designed for the purpose of creating great learning experiences that improve learning outcomes."

Whether the next steps are evolutionary or revolutionary is up for grabs.

All of these authors acknowledge, in one way or another, the watershed 2015 EDUCAUSE white paper that first defined and called for the NGDLE. They also all agree that the real work of architecting the NGDLE will take us beyond the metaphors and the visions. This real work is crucial, and it will not be easy. Whether the next steps are evolutionary or revolutionary is up for grabs—as is the question of whether the charge should be led by vendors, IT pundits, CIOs, faculty, or students. Most likely, as in so many other areas of higher education, the development of the next generation of digital learning environments will require contributions from all of the above.

John O'Brien (jobrien@educause.edu) is President and CEO of EDUCAUSE.

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Six Steps to Innovation

While all leaders recognize the need for innovation in product, process, and services, the word *innovation* has many meanings. It is perhaps the most ubiquitous word in both business and higher education lexicons today, yet there is seldom a common meaning of the term. Everyone wants an "innovative business model," but what exactly does that mean?

In higher education today, an obvious question is whether the traditional classroom lecture—even with PowerPoint, video, or other technology—is the most effective pedagogy. Teachers know that students readily use their search devices to find needed information and often tune out lectures while surfing their computers or handheld devices. Given this new reality, what is the best way to teach subject knowledge today?

At Bryant University, our rethinking of innovative teaching and the design of our new Academic Innovation Center came after we concluded that teaching innovative skills and traits to each student was vital because innovation in the workplace will be increasingly important in the future. So we asked ourselves a series of questions: Can we teach all students to become innovators? What skills must they develop? And can we assess the learning of these skills and traits?

> How can we create a culture focused on encouraging innovative teaching and giving students the skills they need to become innovators?

Creating innovators requires more than simply teaching about entrepreneurship or differently designed products. It should also include an education about the innovation process that will enable graduates to make innovative advances in their future chosen fields, regardless of their major. In this education about the innovation process, students will discover something that Walter Isaacson observed in his bestselling book *The Innovators:* even in technology, innovation is almost never a single-person achievement.

While there is not yet a universal definition of *innovation,* a body of knowledge about the subject has been growing exponentially in recent years. Some of the early thought leadership came from IDEO, a California industrial design firm that realized there was a methodology in the way it approached industrial design as creative problem-solving. IDEO shared its methodology, and now "design thinking" enables businesses and academic institutions to use their pedagogy for institutional purposes. For higher education, this does not mean changing core academic content. Innovation is not an academic discipline, but it can be a skill process, and it should mean overlaying core competencies with the innovative traits and skills needed in future graduates.

The design thinking approach to creative problem-solving has six steps: observation, ideation, rapid prototyping, user feedback, iteration, and implementation. With this approach in mind, we have gone through the six steps to create a culture focused on encouraging innovative teaching and creating innovators at Bryant University.

Step One: Observation. Five years ago, we began teaching design thinking to every freshman in a 56-hour "boot camp" immersion experience that introduces students to the design thinking process and challenges them to apply it to real-world problems. This is our Innovation and Design Experience for All (IDEA) program.

Step Two: Ideation. We then began to apply design thinking as a first step to envision how our faculty, in a new world of technology, could go beyond PowerPoint presentations to a fully integrated pedagogy of experiential learning in the classroom. We started with one prototype classroom, The Ideation Lab, and some adventurous faculty who had participated in the IDEA program. The classroom itself wasn't too futuristic, but the core group of faculty using the room were known for teaching innovatively. They experimented, evaluated results, and made significant improvements.

Step Three: Rapid Prototyping. We created an additional prototype classroom in our Bello Center and Library. This second prototype was more sophisticated in its use of wireless technology and audiovisual capabilities, with movable tables and chairs for easy reconfiguration of the space for team tasks.

Step Four: User Feedback. Throughout the pilot projects, we had received feedback from pioneering faculty who taught innovatively, had been part of IDEA, and were ready to imagine a whole new building that would reflect the lessons they had learned. We wanted an active, fluid learning environment—a flexible, open, and transparent space with light and movable furniture and state-of-the-art technology tools. We envisioned group-integrated experiential learning in flipped classrooms and many other possibilities.

Opened in September 2016, Bryant's Academic Innovation

By RONALD K. MACHTLEY

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Center is the culmination of years of planning and exploration. Gone are the rows of seats and the lecture dais that characterized higher education for centuries. Instead, flexible spaces, modular furniture, and the latest technology allow for a wide variety of teaching and learning styles. The focus is on innovative teaching, group interactions, and dynamics. The technology is user-centric and provides tools that help to visualize, organize, and crystallize ideas while promoting effective communication and collaboration among individuals and teams. At the center is the light-filled Innovation Forum. The building also has 5 tiered classrooms, 5 flat classrooms, 23 breakout study rooms, lounge seating, a welcome center, and a café.

A faculty committee helped ensure that the design of the new classrooms was exactly what they wanted for teaching innovatively. Those who wanted to teach in the building had to submit their syllabi to a committee. They worked closely with our campus IT experts. The classrooms were designed to encourage the generation of original ideas and new knowledge. Abundant writable glass, whiteboard surfaces, and movable furnishings complement smart technology wireless projection, wireless monitors at group collaboration stations, and docks for multiple devices such as laptops, tablets, and smartphones. The innovative learning spaces enable faculty and students to work side by side and more effectively engage as they access worldwide data, create and share content, and view and critique solutions. The teacher load was divided between the College of Business and the College of Arts & Sciences, with students in all four years of classes equally participating in the use of the facility.

Step Five: Iteration. We recognized that our entire community should have a rich culture of innovation. We created many programs, such as "Faculty Without Borders" and the Sophomore International Experience. An event held each spring, Research & Engagement Day, provides an opportunity for faculty and students to share experiences, whether a research project, independent study, or classroom activity. It is this kind of sharing that helps build a community around teaching.

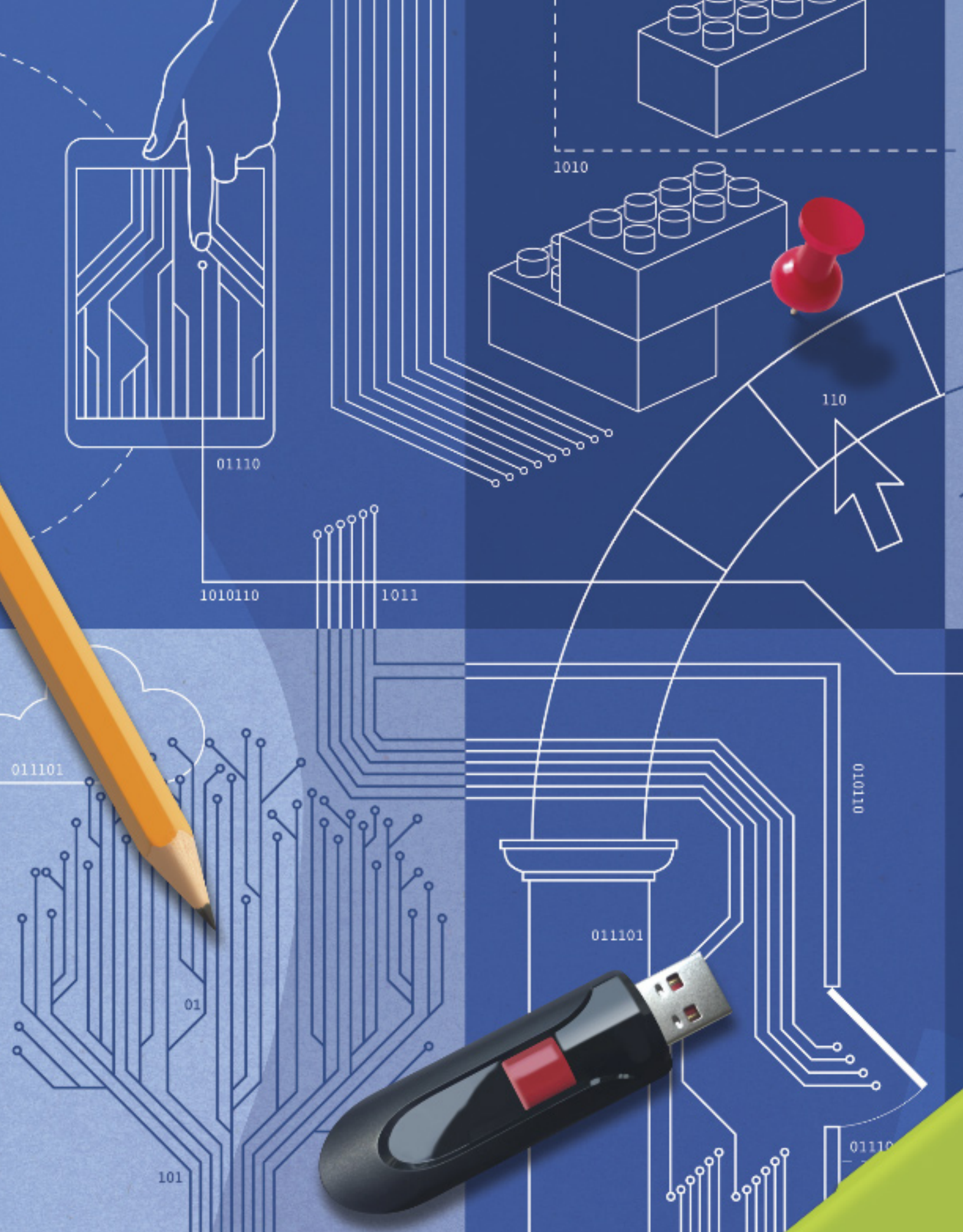
Step Six: Implementation. We decided that our goal was not only to teach innovatively but also to develop within all students the traits, skills, and qualities that will make them innovative leaders. Innovation involves not just teaching them how to design a product or engineer a process or develop the next IT venture that can achieve an IPO; innovation is also a way of thinking and collaboration and, yes, failure.

In dynamic collaboration, we established a definition of that elusive word *innovation*: "The process of creating and implementing an idea that generates significant positive change that the user values." The last part is crucial: innovation must be something that the user values, not merely a good idea. We then identified five traits of innovators: *Curiosity and Creativity*; *Integrative Thinking*; *Collaboration*; *Connectors*; and *Perseverance and Grit.* Our students are learning those defined traits as well as the core of academic courses. And as we all know, in higher education we must develop the tools to measure and assess. We have begun the process of determining how we will assess accomplishment in this area, including whether and why students learn more of the academic content through innovative teaching than through the conventional lecture method.

We have not found, nor do we expect to discover, an all-purpose teaching method that is optimal for all. That is neither realistic nor desirable. The challenge of educational innovation is for teachers to think anew about their unique disciplines and how they might deliver knowledge in different, more effective ways. That challenge to be innovative is why our faculty are invigorated. They are enjoying the creativity and freedom that inspired them to teach in the first place.

Innovation is a continuing journey, of course. There are countless steps ahead of us as we learn, teach, plan, and build. But at Bryant University, we reflect on recent progress with satisfaction. We honor our faculty for teaching innovatively, and we take pride in our students for working to become true innovators. ■

Ronald K. Machtley (innovation@bryant.edu) is President of Bryant University.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THE NGDLE

We Are the Architects

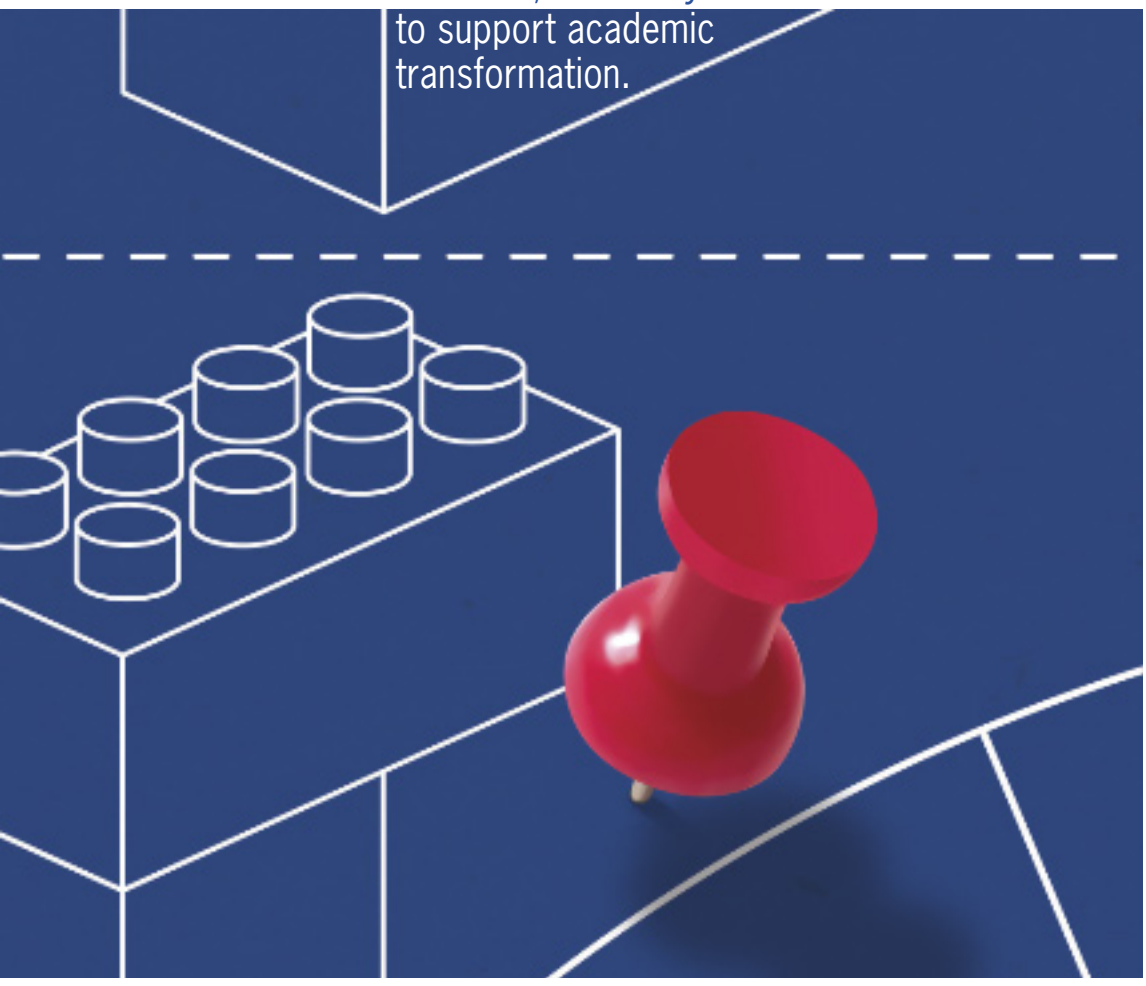
Malcolm Brown

In April 2017 the **next generation digital learning environment** (NGDLE) framework celebrated its two-year anniversary. In the course of those two years, the unpronounceable and mildly unsightly acronym "NGDLE" has developed a life of its own. It did so against all odds. Indeed, Jon Dron at Athabasca University remarked immediately after the release of the 2015 white paper on the NGDLE: "NGDLE is an appalling acronym! By definition, it is unlikely to catch on."[1] In this assertion, Jon was both right and wrong: right about it being appalling, perhaps, but wrong in another respect: it did catch on. As of this writing, a Google search on the term produces close to six thousand hits.[2]

That said, it is useful to look back and see where this homely acronym came from. The research that resulted in the April 2015 NGDLE white paper[3] was made possible by a grant from the Bill & Melinda Gates Foundation. Both the Foundation and EDUCAUSE were interested in the question of what the next learning management system (LMS) might look like. The research began in the summer of 2014. As all researchers know, a key to doing good research is finding the right question, and the team quickly discovered that a question asking about the next generation LMS was the *wrong* question. Very early in the research process, Randy Bass of Georgetown University pointed us in the right direction when he said in an interview with the research team: "If it's an environment that's somehow being provided by a single enterprise system, then no, stop now. . . . It seems to me it's a worthy goal to ask: 'How is it going to optimize the environment around it for education?'" Clearly, anything that was a *system* (the "S" in "LMS"), in the sense of a one-size-fits-all approach, was by itself a dead end.

So the focus shifted to environments. To address the challenges and opportunities facing higher education, whatever was next would need to be *next generational*, meaning that it requires out-of-the-box thinking and, above all, the ability to support academic transformation—change that is both strategic and institutional in scope.[4] It also needed to be *digital*, since almost everything concerning learning in higher education touches or is enabled in one way or another by digital technology. Further, it needed to be about *learning*, meaning a learner-centered focus, providing the basis for both instructor and learner success. Since it is about learning, it has to offer ways of moving past the fixation on the traditional course and the administration of courses. And finally, it needed to be an *environment*, a setting comprising many interacting components that enable learning of all kinds to flourish. Hence the rather lumbering name for this what's-next thing became the *next generation digital learning environment*. As is most often the case (as also with puppies and kittens), the first name stuck, and so the NGDLE acronym was unleashed on an unsuspecting higher education world in April 2015.

To address the challenges and opportunities facing higher education, whatever was next would need to be *next generational*, meaning that it requires out-of-the-box thinking and, above all, the ability to support academic transformation.



Over the past two years, one point continues to crop up in discussions about the NGDLE. That question is whether the NGDLE argues for or against the LMS. One important aspect of the NGDLE is its Zen-like emptiness. A subtitle we could have bestowed on the white paper (had we thought of it at the time) might have been: "The LMS in the Post-LMS World." Established LMS vendors will argue that even in the context of a component-based architecture woven

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together by open standards, a hub will still be needed—a role played by the LMS. In fact, in his article in this issue of *EDUCAUSE Review,* John Baker explains: "The LMS needs to be a *central nervous system* that connects the components (the bricks) in a unified learning ecosystem." Others espouse a radically decentralized approach, which we might call the "we don't have to show you no stinkin' LMS" school of thought: use the tools relevant to you and connect them (or not) as needed.[5]

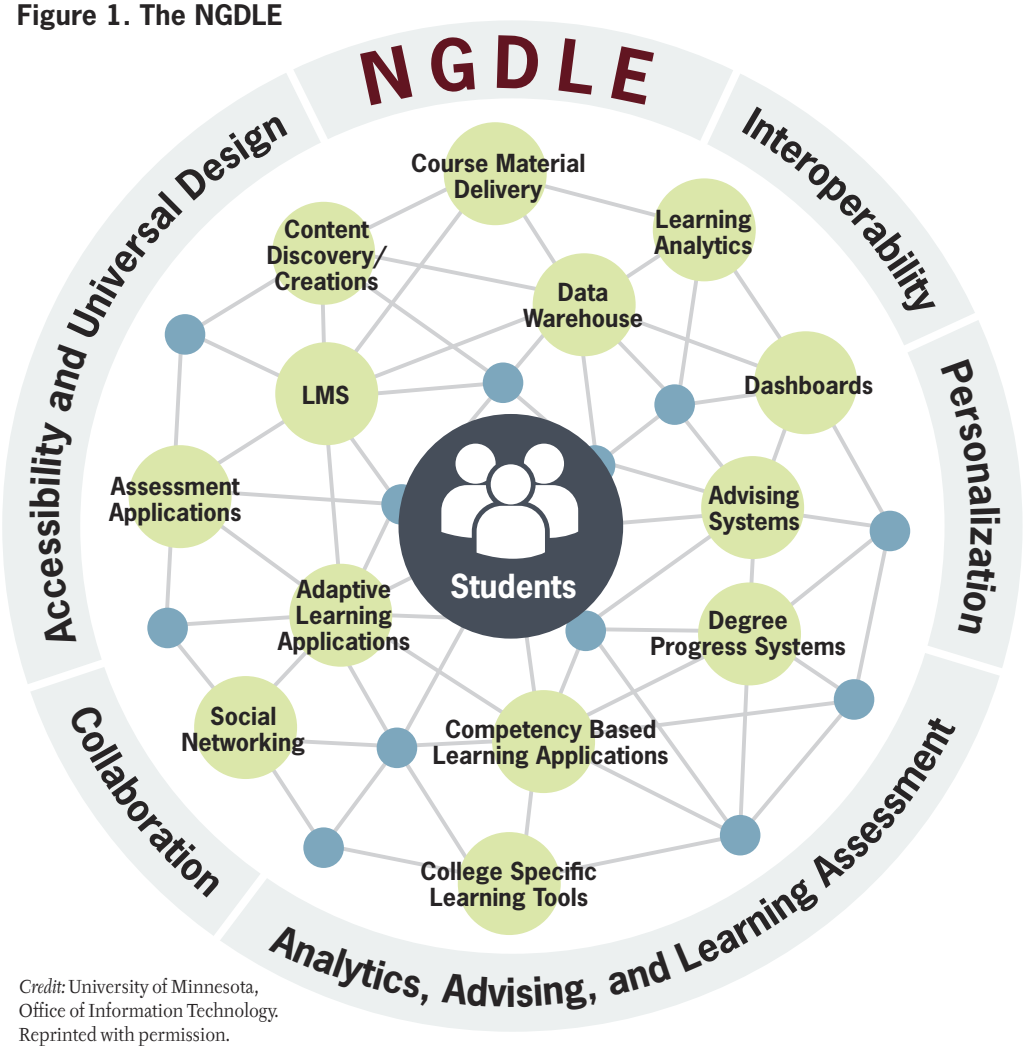
The future role of the traditional LMS is an important consideration and worthy of careful discussion. In practical terms, the LMS will continue to be a hub for most institutional learning environments for the foreseeable future. However, while the NGDLE concept espouses a component-based architecture, it does not prescribe which components. It makes no recommendation on vendor vs. local applications or on commercial vs. open. One institution might use the LMS as a hub, another might not. In short, it is up to individual institutions (or possibly consortia of institutions) to decide which components best serve their learning needs and requirements. In light of the NGDLE's aspiration to serve as a framework that enables institutions to address their very diverse learning needs, it must remain agnostic in this respect. The key in the NGDLE framework is not the to-be-or-not-to-be LMS question but, rather, the importance of interoperability on many levels, a characteristic that enables a diversity of function and a coherent environment experience. Stephen Laster's article in this issue explores this cornerstone idea of interoperability based on open standards.

The NGDLE vision of a web or network of educational applications has been captured graphically by the University Learning Technology Advisors (ULTA) at the University of Minnesota. Figure 1 shows the LMS as a component of the network. Just how the LMS operates as a hub and fits into the larger network is left as an exercise for each institution.

So now let's look to the future: What's ahead for next generation digital learning environments? First, I would urge us to think "next generationally" in a way suggested by Phil Long and Jon Mott in their article here. We should think not only about how to build a true digital learning environment in a technical sense but also about our strategic destinations. What new directions and opportunities might something like the NGDLE afford our institutions? Might it even encourage us to fiddle with our paradigms of higher education?

Also ahead is a lot of inventive and innovative work. Michael Feldstein concludes his article in this issue right at this point. I would add that this venture will require "all hands on deck" if we are to make meaningful progress. All of us, from all walks of higher education, will need to work in concert in order to make progress.

Figure 1. The NGDLE



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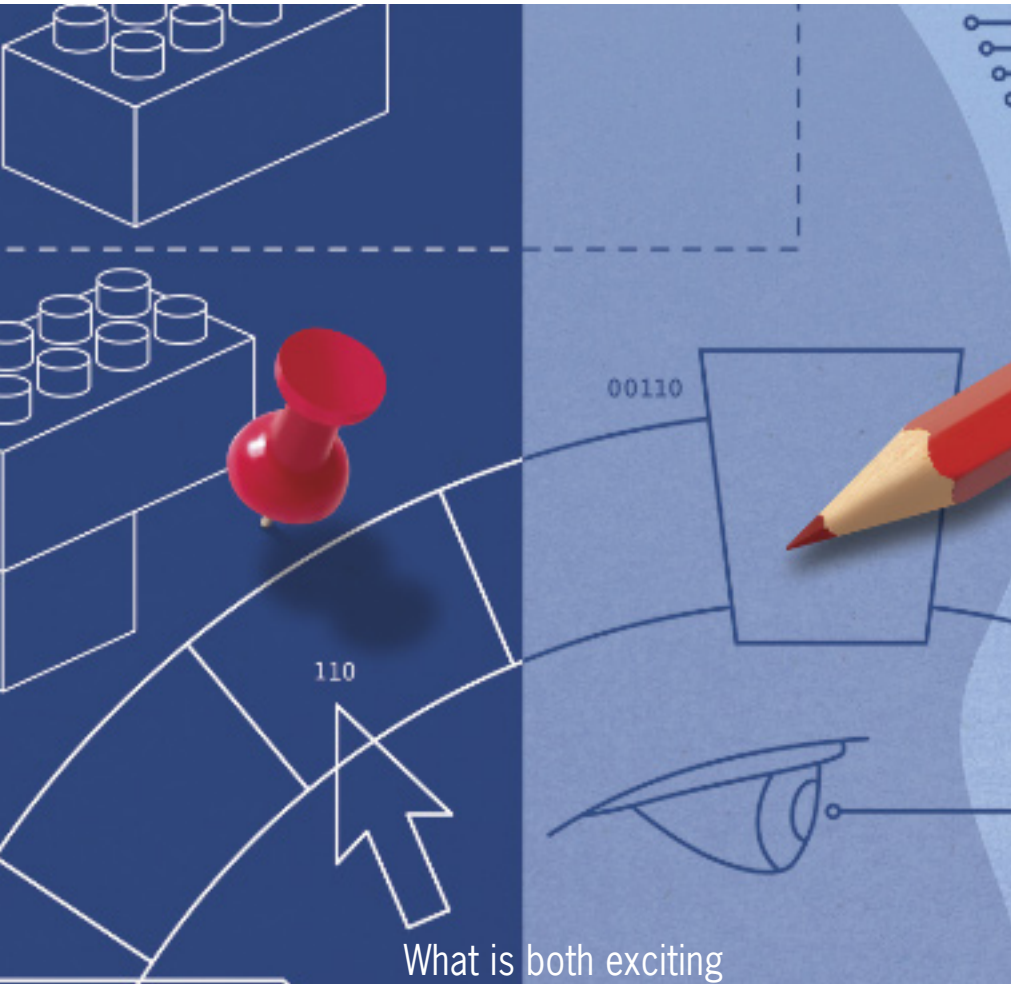

What is both exciting and daunting is that the shift to a component-based approach provides an unprecedented opportunity to shape, rethink, plan, and design our digital learning environments.

To be more specific, I believe we need to address the following four areas:

- *Interoperability*. In the 2015 white paper, we remarked that "interoperability is the linchpin of the NGDLE." I haven't come across anyone who disagrees with that idea. But that doesn't mean that interoperability will magically unfold before us. We'll need to do a full-court press on the development and implementation of open standards. Certainly IMS Global's role is obvious and conspicuous. But the rest of us have important roles to play as well. We'll need to establish an effective dialogue with the vendor community. We'll also need to attend to our procurement practices to ensure that we are effectively articulating and insisting on the right academic components to do the job. Wherever we can, we should band together into consortia and other kinds of cooperatives to make progress in this area.
- *Enterprise IT, the CIO, and the IT Organization*. All too often, we see enterprise information technology and academic information technology as operating on separate planets. But enterprise IT, along with the CIO and the IT organization, has an important role to play with respect to making progress toward learning environments based on application components. Indeed, on the enterprise side there is talk about "next generation enterprise," which suggests a point for the academic and the enterprise folks to initiate dialogue.[6] As Vince Kellen suggests in his article, there is a vital role for the campus CIO as a strategic planner who can help form the alliances and institute the practices needed to make progress.
- *Learning Data*. I think we'll see the most conspicuous progress over the next two years in the area of learning data. Standards like Caliper and xAPI finally provide a kind of Esperanto for learning data. The combination of the component-based approach and these standards affords an unprecedented opportunity for the collection and analysis of learning data, all in service to learner success. As this issue of *EDUCAUSE Review* goes to press, there are institutions already out of the gate that are beginning to implement learning data "networks" on their campuses. I would suggest that there is an opportunity to accelerate our thinking and planning with respect to the range and extent of learning analytics at our institutions. We should all be holding discussions on this point.
- *We, the Architects*. I've made this point elsewhere, but what is both exciting and daunting is that the shift to a component-based approach provides an unprecedented opportunity to shape, rethink, plan, and design our digital learning environments.[7] An architect is a proactive agent who looks to plan structures and environments to accommodate future usage. By taking the component approach, we can all adopt an architect's perspective and work to design the learning environments we want and need.

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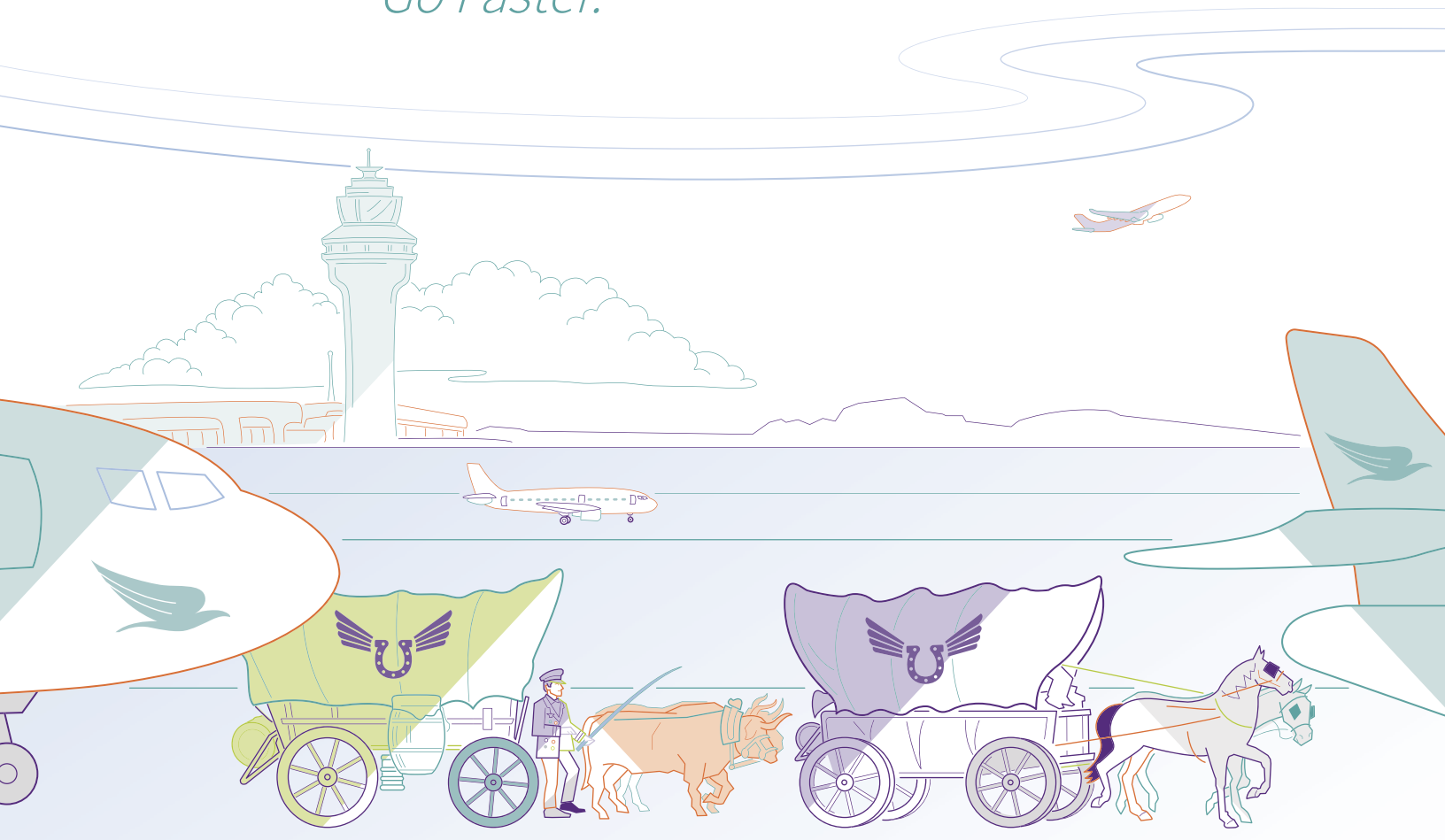

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In the months ahead, EDUCAUSE will be working with the higher education IT community to promote the realization of next generation digital learning environments. We will be devoting space at our events and in our publications to discussing, sharing, and brainstorming about ways to move ahead. As you gain insights in this area and make progress toward your goals, we encourage you to share those insights. We welcome all ideas from you, our community members and fellow architects.[8] ■

Notes

1. Jon Dron, "EDUCAUSE Looks Beyond the (Current) LMS Environment: Is It a Future We Want?" *Athabasca Landing*, May 12, 2015.
2. Granted, a few of those hits relate to a book on Spanish linguistics. "NGDLE" is also an abbreviation for *Nueva Gramática de la Lengua Española* (Madrid: Espasa Libros, 2009).
3. Malcolm Brown, Joanne Dehoney, and Nancy Millichap, *The Next Generation Digital Learning Environment: A Report on Research*, an EDUCAUSE Learning Initiative (ELI) white paper (April 2015).
4. In the discussions of the NGDLE over the past years, observers have frequently stated or implied that the NGDLE is not "next generational" because the idea of component-based environments is not new and dates back at least a decade. For example, Clint Lalonde wrote: "While it is being tagged with "Next Generation," it is an idea that has been around for awhile now" ("NGDLE and Open Edtech," *ClintLalonde.net*, February 25, 2016). One could also argue that other predecessors of the NGDLE are the E-Learning Framework, the Open Knowledge Initiative (OKI), and the work that Michael Feldstein describes in his article in this issue of *EDUCAUSE Review*. No doubt there are other antecedents. Our use of the term "next generation" was not meant to exclude the acknowledgment that the NGDLE framework stands on the shoulders of giants, as the expression goes.
5. See Simon Thomson, "An Edtech Future without More Edtech," *Digisim*, November 4, 2016.
6. One of the EDUCAUSE Top 10 IT Issues for 2017 is "Next-Gen Enterprise IT: Developing and implementing enterprise IT applications, architectures, and sourcing strategies to achieve agility, scalability, cost-effectiveness, and effective analytics."
7. Malcolm Brown, "6 Implications of the Next-Generation Digital Learning Environments (NGDLE) Framework," *Transforming Higher Ed* (an *EDUCAUSE Review* blog), June 27, 2016. See also Rob Abel, Malcolm Brown, and Jack Suess, "A New Architecture for Learning," *EDUCAUSE Review* 48, no. 5 (September/October 2013).
8. One venue for sharing your ideas is the EDUCAUSE blog *Transforming Higher Ed*. If you have an idea for a blog post, please contact me at mbrown@educause.edu.

Malcolm Brown (mbrown@educause.edu) is Director of the EDUCAUSE Learning Initiative (ELI).

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UNCOMMON THINKING FOR THE COMMON GOOD

The N²GDLE Vision: The "Next" Next Generation Digital Learning Environment

Phillip D. Long and Jon Mott

Two years ago, the EDUCAUSE Learning Initiative published its widely cited white paper *The Next Generation Digital Learning Environment: A Report on Research*. The authors' objective was to "explore the gaps between current learning management tools and a digital learning environment that could meet the changing needs of higher education." In doing so, they joined a long line of critics and reformers who had similarly observed that the learning management system (LMS) had been "highly successful in enabling the administration of learning but less so in enabling learning itself."[1]

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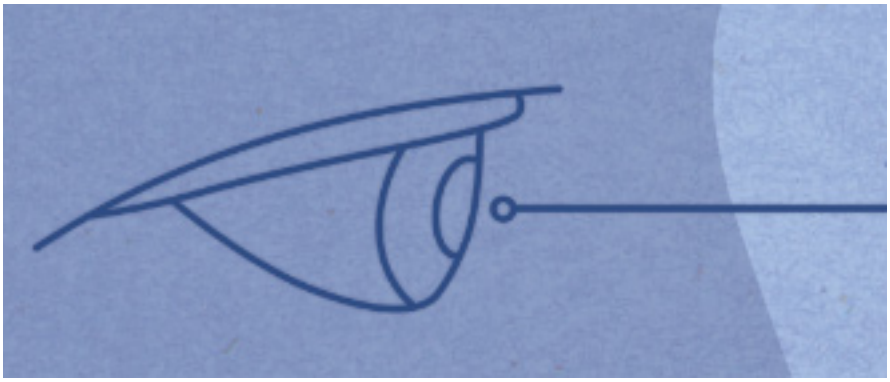


Since the very dawn of the LMS era, learning theorists, practitioners, and technologists have expressed concerns about a technology paradigm inherently focused on "managing" learning. Indeed, multiple studies and reports have concluded that the LMS is largely used for content distribution and administrative purposes and, therefore, is not a significant driver of innovation and fundamental change in higher education.[2]

So where do we go from here? To the "next" next generation digital learning environment—or what we have dubbed the "N²GDLE."[3] We believe that learning technology is maturing to the stage that it can be an "exoskeleton" for the mind. Higher education is on the cusp of a tectonic shift that will see human learning and intellectual capability substantially augmented by technology. But we need to move beyond LMS-centric thinking to realize that potential.

An Exoskeleton for the Mind

Why do we need to move beyond the LMS "instructor paradigm" technologies and thinking about learning? Simply put, we face an urgent societal need to fully, efficiently, and effectively help *all* individuals realize their potential as learners and practitioners across an expected lifetime of learning. This cannot happen through current methods and tools for knowledge dissemination. We must unlock human potential by empowering all individuals to learn and contribute meaningfully in disciplines and fields of their choosing. We must utilize the tools we have at our disposal to finally close Benjamin Bloom's 2-sigma gap in achievement between personally tutored students and students in a traditional classroom.[4]

Augmenting Human Intellect: A Conceptual Framework, a 1962 SRI Summary Report, provides a touchstone for thinking about technology in service of human endeavors. Doug Engelbart, the author of the report, states in the introductory paragraph:

> Increased capability in this respect is taken to mean a mixture of the following: more-rapid comprehension, better comprehension, the possibility of gaining a useful degree of comprehension in a situation that previously was too complex, speedier solutions, better solutions, and the possibility of finding solutions to problems that before seemed insoluble. . . . We do not speak of isolated clever tricks that help in particular situations. We refer to a way of life in an integrated domain where hunches, cut-and-try, intangibles, and the human "feel for a situation" usefully co-exist with powerful concepts, streamlined terminology and notation, sophisticated methods, and high-powered electronic aids."[5]

What Engelbart describes here amounts to an "exoskeleton for the mind." The suggested approach leverages technology to enable more effective interrogation of facts, concepts, and ideas, ultimately instilling habits of mind including meta-skills or attributes like curiosity, open-mindedness, intellectual courage, thoroughness, and humility. Technology, properly designed and implemented, can indeed function as a set of tools and processes that augment human learning and intellectual capability.

Since the dawn of the computer, instructional designers and learning scientists have envisioned the emergence of "intelligent tutoring systems" (ITSs) that would approximate the benefits of a live tutor. Unfortunately, ITSs have not lived up to their hoped-for potential. Most college and university classes are taught largely the way they were before the computer age.

Why is this the case? Early ITS efforts incorporated sound principles of instructional design: begin with the learning goal in mind, decide how it will be measured, then determine how students will be enabled to move from where they are to the achievement of the goal. This process of "backward design" was at the heart of pre-web learning systems built on centralized, "heavy iron" computers.

Through the 1970s and 1980s, ITS development and deployment saw some notable successes but was largely limited to specific disciplines (notably language instruction) and corporate training contexts. Fully mapping a learner's complete journey through a sequence of increasingly complicated learning outcomes was simply too expensive and too complicated. Even more importantly, the ITS model threatened to undo the roles and relationships at the heart of education. If a computer could intelligently tutor, what was the role of the teacher? Was the classroom experience necessary? The tension in these questions was never resolved, and attention from them was diverted with the emergence of networked computers.

The focus on collaborative learning networks grew exponentially with the birth of the Internet and the World Wide Web. The paradigmatic change accelerated the marginalization of now passé ITS-like systems. Focus and attention shifted to resource sharing, web-based discussion, idea sharing, and collabora-

tion. In its earliest manifestations, networked learning in higher education was grassroots, with innovative faculty members building course web pages replete with hyperlinked resources. The more adventurous faculty included discussion boards, polls, and quizzes. The unstoppable democratization of the web soon yielded tools that all faculty members could use to build their own course web pages.

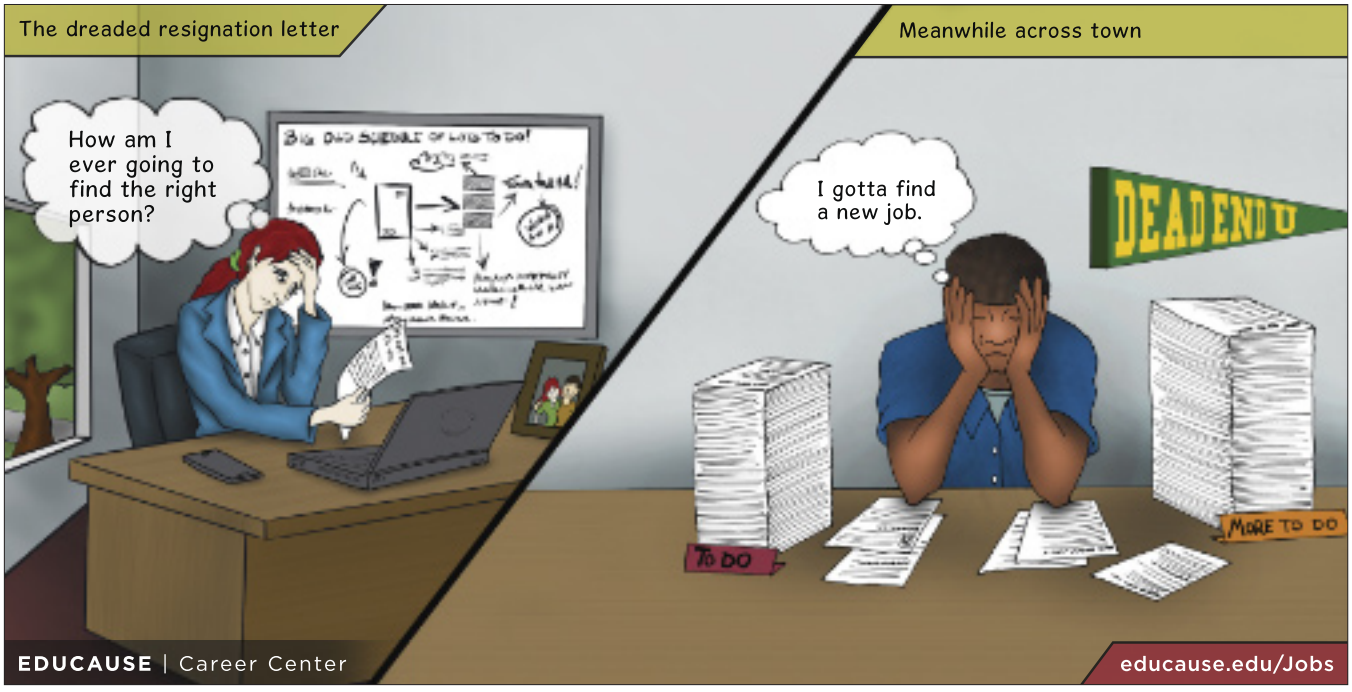
In 2017, the ascendancy and ubiquity of personal computing is taken for granted. We do more on mobile devices today than was dreamt of with early PCs.[6] But what happened to the vision of intelligent tutoring technology that was to become the exoskeleton for learners' minds? For much of the past two decades since the birth of the LMS, technological innovation in teaching and learning has been focused on collaboration and new and better ways to present content. Unsurprisingly, neither of these domains has led to significant change to the traditional roles of or relationships between teachers and learners.

Because the LMS is anchored in semester-based sections of instructor-led courses, anything resembling an innovation is largely "bolted on" rather than transformational. Although this is heading in the right direction, simply adding collaboration and assessment tools to the LMS leaves core learning processes and roles largely unchanged. As a result, there is no significant change in the ways learners are provided context and guidance as they work to achieve their learning and credential goals.

While there has been consistent, incremental, feature-adding innovation from the LMSs, the most (potentially) transformational recent developments have come from a return to the promise of the ITS. Numerous adaptive learning providers have emerged, making the same aspirational promises as the proponents of the ITS model forty years ago. But this time around, a voracious appetite for innovative solutions that promise to improve learning and a willingness to work through or ignore the fundamental challenge to traditional instructor and student roles are providing fertile ground for an intelligent tutoring renaissance. Because of advances in technology and learning science—with growing urgency around retention, persistence, and completion—adoption of these systems has increased.

We believe that learning technology is maturing to the stage that it can be an "exoskeleton" for the mind.

How could the adoption of networked learning technology (i.e., the LMS) pave the way for the reemergence of the once universally rejected ITS model? The familiarity of the LMS and the ubiquity of "big data" and "recommendation engines" in other parts of our lives have diminished resistance to the idea of computers prompting and guiding decision making and "pathing" in the learning process. We have witnessed a slow, natural-selection process that brings us to the possibility of the N²GDLE vision, a model that includes the networked learning capabilities of the traditional LMS and the computer-guided learning vision of the ITS. The N²GDLE will augment



and enhance learning by connecting learners with instructors and fellow learners meaningfully in structured ways to enable, accelerate, and support the learning process. By adaptively and dynamically updating learners' paths across programs, the N²GDLE increases the probability that students will achieve completion and earn credentials. The transformational impact of the N²GDLE will not come by simply arranging and presenting content in more innovative ways. Rather, it will come through the synergistic combination of networked learning and smart pathing, enabling instructors to track the complex pathways being taken by large numbers of students and make timely, pinpointed interventions and nudges to propel cohorts and individuals along their way.

The N²GDLE Model

The 2015 NGDLE white paper explicitly called for progress in five key areas: (1) Interoperability and Integration, (2) Personalization, (3) Analytics, Advising, and Learning Assessment, (4) Collaboration, and (5) Accessibility and Universal Design.

These are unarguably critical areas to focus on with regard to a high-quality digital learning environment (DLE). As important as all of these are, they are in some ways too generic to describe the kind of transformational DLE that is required to take us into the "next generation" of teaching and learning. A modern DLE of any generation is virtually unthinkable without standards support built in, readily available to connect and share data with a myriad of other tools and services. If the N²GDLE is to support both networked and adaptive learning models, it will almost certainly include learning tool components that need to talk to each other. Standards-based integration and interoperability enables each component of a federated DLE to do a single thing or a few things very well—instead of trying to do all things poorly.

Both of us have committed significant time and energy to learning technology standards and specification definition, refinement, and implementation, particularly through IMS Global (https://www.imsglobal.org/). Initially a project of EDUCAUSE, IMS spun off as an independent organization in 1999. Functioning as a nonprofit, it brings together institutions, vendors, and practitioners to identify, design, adopt, and validate learning technology interoperability standards available under royalty-free licenses (see sidebar).

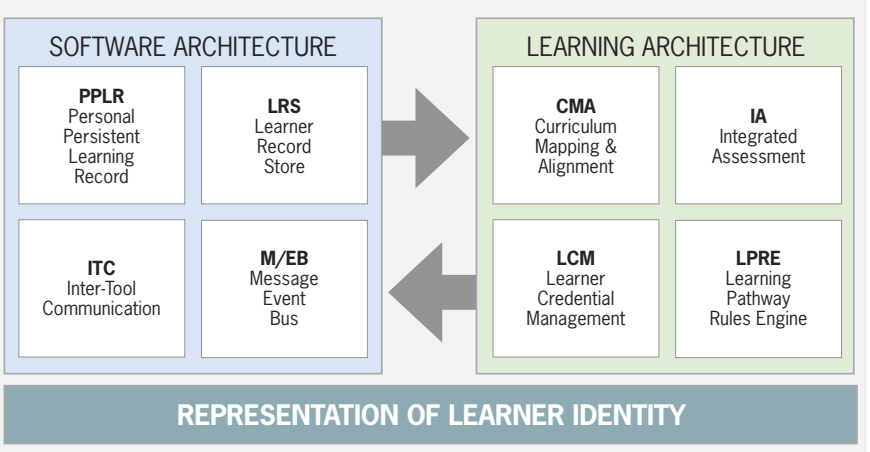
As new adaptive, competency-based, and programmatic learning platforms emerge, they are likely to be integrated with existing LMSs and a range of other tools. As envisioned in the 2015 NGDLE white paper: "If the equivalent of the Lego specification could be articulated for the NGDLE, it would serve as the basis for the confederation we propose. We are suggesting an NGDLE-conformant standard or specification, which would be based on adherence to a coordinated set of component standards. Once such a standard is in place, future investments and development efforts could be designed around the NGDLE specifications."

Our vision for the N²GDLE builds on the vision of an interoperable, Lego-model DLE. It assumes interoperability. And it incorporates both the networked learning model of the LMS and the adaptive, personalized learning model. While assuming many of the elements initially envisioned for the NGDLE, we reframe the 2017 version with two major categories of required components: software architecture and learning architecture (see figure 1).

Selected IMS Global Learning Technology Specifications and Initiatives

- Maturation and adoption growth of the Learning Tool Interoperability (LTI) specification v1.2 and 2.0
- Caliper 1.0 analytics specification (and initial alignment with xAPI)
- Open Badges Initiative (OBI) 2.0 Candidate Final
- Competency Based Education / Extended Transcript Project
- OneRoster v1.1
- Thin Common Cartridge v1.3 and Common Cartridge v1.3

Figure 1. N²GDLE Components



Software Architecture

Personal Persistent Learning Record (PPLR): While it might have been possible for a traditional LMS vendor to assert that it met all the requirements of the original NGDLE, the N²GDLE is different at its roots. Most significantly, it is built from the ground up around individual learners: their learning goals, activities, assessments, and achievements. The N²GDLE, therefore, requires a *personal* student learning record that tracks learner engagement in and with programs, courses, learning activities, content, other students, projects, internships, and co- and para-curricular experiences. It will also provide holistic, integrated views of a learner's experience across all of these (currently disparate and siloed) experiences.[7] This vision explicitly requires the PPLR to receive learning activity and achievement data from multiple sources and systems. Since it serves as the repository of *all* learner goals, achievements, activities, and interactions, it necessarily includes data from multiple learning platforms, environments, and even institutions. Data interoperability and formatting standards—via Inter-Tool Communication and the Message/Event Bus discussed below—are absolutely essential to the PPLR.

Learner Record Store (LRS): The LRS is fast emerging as the system of record for transactional learning and achievement data. The transactional LRS includes a meta-layer of learner behavior data that is essential to an understanding of and intervention in the learning process. The IMS Global's Caliper and xAPI standards are enabling frameworks for instrumenting data so that it is dynamically emitted by the systems used by learners and is then "sensed" and stored in the LRS.

We reframe the 2017 version of the NGDLE with two major categories of required components: software architecture and learning architecture.

Inter-Tool Communications (ITC): In the Lego model, multiple tools can be used seamlessly throughout the learning experience. Not only is single-signon launch and use of these tools essential, but they must also be able to communicate with each other. In some cases, a simple data return from a launched tool back to the consumer is sufficient. In other cases, an N²GDLE designer, a learning engineer, an instructional designer, or a faculty member might want two or more tools to more actively "listen" to each other. In these cases a persistent, real-time Message/Event Bus (see below) may be required.

Message/Event Bus (MEB): As tools in the N²GDLE multiply, the need for dynamic, real-time messaging between them is critical. Every tool generates its own activity stream log. But some events are more important and relevant than others. Learning tools are increasingly likely to support the monitoring of these events with sensors. They act to transport the pulses of synaptic activity recording the learning interaction. This is information that has value not just for the learner's immediate progress through a learning sequence but also for actions that might be taken by related supporting systems

and tools (as described above). Timely actions require stream processing, and that stream is the MEB.

Learning Architecture

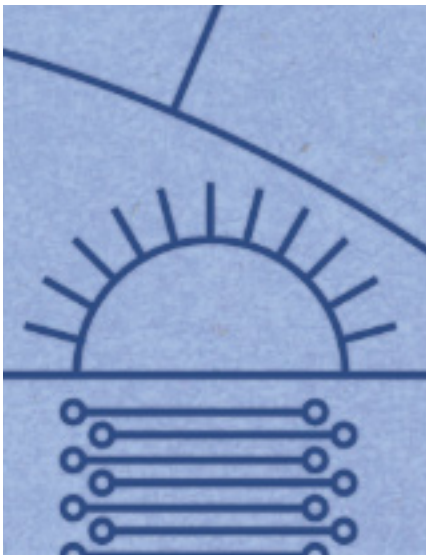
Curriculum Mapping and Alignment (CMA): Most currently available learning environments do not readily enable curriculum managers, learning engineers, instructional designers, and faculty members to document learning outcomes and competencies and then establish *dynamic data relationships* (e.g., via meta-tagging) among those outcomes, the learning activities intended to help learners achieve them, and the assessments designed to measure (formatively or summatively) their progress toward and demonstration of the outcomes. The N²GDLE must allow various curricular stakeholders to create these maps; ensure alignment between outcomes, activities, and assessments; monitor learner progress through backward-designed and aligned programs; see individual and cohort data to drive success; and then analyze data periodically to improve the curriculum. More advanced versions of CMA functionality would allow learners to specify their own learning goals, map them to learning activities and experiences, and discover ways to self-validate achievement of those goals.[8]

Integrated Assessment (IA): Once learning goals or competencies have been articulated and aligned with assessments, those assessments need to be presented to learners in the right sequence and flow of the learning experience. Curriculum designers and learning engineers need the ability to deploy a formative assessment anywhere, anytime. Support must also be provided for multiple assessment types, including a variety of traditional computer-scored items, interactive assessments and simulations, homework activities, and rubric-based assessments of student work or performance. Any and all of these should be easily integrated at any juncture of the curriculum, in either formative or summative mode.

Learner Credential Management (LCM): LCM is an essential component of the N²GDLE because it allows institutions to decide what credentials they will grant when learners demonstrate various competencies. Associate's and bachelor's degrees are as important as they ever were, but other kinds of credentials—including badges, certificates, and other forms of microcredentials—are growing in relative importance. Institutions need the flexibility to grant credentials for the knowledge, skills, and abilities they want to certify for their learners.

Learning Pathway Rules Engine (LPRE): An LPRE enables N²GDLE administrators, learning engineers, and others to establish rules, triggers, and logic that will dynamically update plans to maximize learning effectiveness and efficiency. This allows for a design pattern library to ease the construction of learning sequences in the N²GDLE. The LPRE opens the door to personalized pathing at the level where it matters most: degree and credential attainment. While it is necessary for students to succeed in their courses, this is not sufficient. They must also acquire the knowledge, skills, and abilities that they can then apply in more advanced courses. And our systems need to be smart enough to direct learners back to review and remediation activities when the learners are struggling to remember or effectively apply previously demonstrated competencies at later stages in a program. For millions of students, this co-remedial approach made possible by the LPRE might literally be the difference between earning credentials and dropping out.

By definition, the N²GDLE will produce learning programs that are aligned with clearly articulated goals and competencies.



Representation of Learner Identity

Finally, learners need the ability to curate their own credentials over time and across multiple institutions and organizations. These credentials can be curated and stored in the learner's exported version of the PPLR, in a portfolio, and/or via extended transcript. But this is not a static record. It needs to be constructed, assembled, and presented differently depending on the audience the learner is trying to reach. Managing the representation of a learner's skills and abilities to potential employers, collaborators, and clients will become an essential capability. Whether loosely coupled with the N²GDLE or closely integrated into it, the representation of learner identity is a must-have component of future DLEs.

The Path Forward

We have outlined an aggressive and aspirational vision of the N²GDLE. Is it possible to have the best of both a networked learning environment and an adaptive learning model implemented in the same "system"? We believe the answer is yes. And the components we describe above are all within reach.

The reasons for such a system are the justification for pursuing, designing, and implementing it. By definition, the N²GDLE will produce learning programs that are aligned with clearly

articulated goals and competencies. Learner progress toward them will be dynamically supported through rich interaction and personalized learning paths. And learner achievements will be validated through competency-aligned assessments.

It would be far too easy to finish reading this article on the N²GDLE (however you pronounce that) and conclude that it is a nice, aspirational thought exercise. Indeed, if we are content with the status quo, we can simply stand pat with the tools, processes, and role definitions that structure teaching and learning at our higher education institutions today. But if we want to transform that structure and dramatically change results, a new paradigm is required. Now is the time to start our journey. ■

Notes

A longer version of this article appears online. This version goes into more detail about the components of the software and learning architecture of the N²GDLE and suggests four concrete steps that might be taken to move a higher education institution toward a new paradigm for digital learning environments.

1. Malcolm Brown, Joanne Dehoney, and Nancy Millichap, *The Next Generation Digital Learning Environment: A Report on Research*, an EDUCAUSE Learning Initiative (ELI) white paper (April 2015), 2.
2. See, for example: Glenda Morgan, "Faculty Use of Course Management Systems," *EDUCAUSE Center for Applied Research (ECAR) Research Study* 2 (2003); George Siemens, "Learning Management Systems: The Wrong Place to Start Learning," *elearnspace*, November 22, 2004; Joanne L. Badge, Alan J. Cann, and Jon Scott, "E-Learning versus E-Teaching: Seeing the Pedagogic Wood for the Technological Trees," *Bioscience Education* 5, no. 1 (2005); Leigh Blackall, "Die LMS Die! You Too PLE!" *Teach and Learn Online*, November 13, 2005; Niall Sclater, "Web 2.0, Personal Learning Environments, and the Future of Learning Management Systems," *ECAR Research Bulletin* 2008, no. 13 (June 24, 2008); Jon Mott and David Wiley, "Open for Learning: The CMS and the Open Learning Network," *in education* 15, no. 2 (2009); Louis Pugliese, "A Post-LMS World," *EDUCAUSE Review* 47, no. 1 (January/February 2012).
3. This is a bit of a tongue-in-cheek name for whatever platforms come next. Given the wide variety of names for emerging technologies, the baggage of the LMS designation, and the painful attempts to pronounce "NGDLE" ("Ung-gud-ull?"), we are intentionally choosing an esoteric name that is unlikely to roll off anyone's tongue. We prefer the rather simpler "learning environment" moniker.
4. Benjamin S. Bloom, "The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring," *Educational Researcher* 13, no. 6 (June–July 1984).
5. Douglas C. Engelbart, *Augmenting Human Intellect: A Conceptual Framework*, SRI Summary Report AFOSR-3223 (Menlo Park, CA: Stanford Research Institute, 1962), 1.
6. See "Processing Power Compared," Experts Exchange (website), accessed April 17, 2017.
7. This approach will rightly challenge the traditional distinction between the curricular and co-curricular dimensions of the collegiate experience. To that end, we encourage academic and student life administrators to reach across the proverbial aisle and rethink the boundaries that separate them.
8. This is in the spirit of self-asserted aspirational badging, wherein learners express their interest in achieving a competency and seek community help to articulate the path toward it. Agreed-upon interim milestones could be formally endorsed by content experts (e.g., faculty) to qualify the steps toward achievement.

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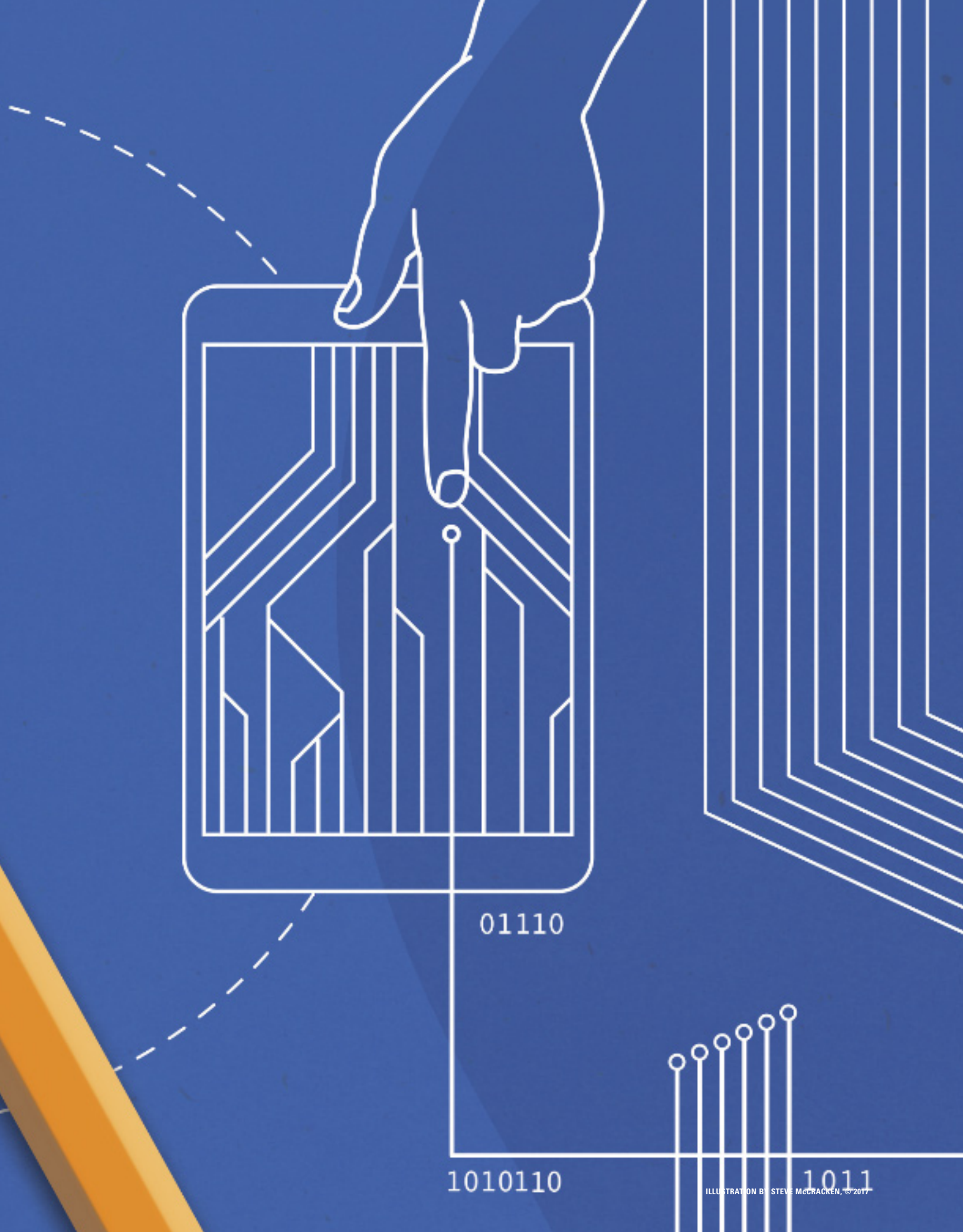

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John Baker

Updating the Next Generation Digital Learning Environment for Better Student Learning Outcomes

By now we're all far too familiar with the new realities of higher education. Educators everywhere are facing tight budgets, experiencing greater competition, and trying to accommodate increased demands for accountability. To top it off, learners themselves are demanding better learning experiences and environments. This is the new normal—and part of the day-to-day lives of postsecondary educators.

Serving this changing population—under these demanding conditions—is challenging for teachers, administrators, and institutions. As educators look for ways to resolve these complex problems, many are turning to education technology (edtech) as one possible solution.

I say this as someone who owns an edtech company: a learning management system (LMS) is never the solution to every problem in education. Edtech is just one part of the whole learning ecosystem and student experience. However, it is an increasingly critical part of the landscape.

Therefore, the next generation digital learning environment (NGDLE), as envisioned by EDUCAUSE in 2015,[1] serves an important purpose: to keep us talking about and better defining our "True North." The NGDLE points us toward the vision and the direction we're all hoping to realize: the improvement of our society through education.

Looking at the NGDLE requirements from an LMS perspective, I view the NGDLE as being about five areas: interoperability; personalization; analytics, advising, and learning assessment; collaboration; accessibility and universal design.

Interoperability

- Content can easily be exchanged between systems.
- Users are able to leverage the tools they love, including discipline-specific apps.
- Learning data is available to trusted systems and people who need it.
- The learning environment is "future proof" so that it can adapt and extend as the ecosystem evolves.

Personalization

- The learning environment reflects individual preferences.
- Departments, divisions, and institutions can be autonomous.
- Instructors teach the way they want and are not constrained by the software design.
- There are clear, individual learning paths.
- Students have choice in activity, expression, and engagement.

Analytics, Advising, and Learning Assessment

- Learning analytics helps to identify at-risk students, course progress, and adaptive learning pathways.
- The learning environment enables integrated planning and assessment of student performance.
- More data is made available, with greater context around the data.
- The learning environment supports platform and data standards.

Collaboration

- Individual spaces persist after courses and after graduation.
- Learners are encouraged as creators and consumers.
- Courses include public and private spaces.

Accessibility and Universal Design

- Accessibility is part of the design of the learning experience.
- The learning environment enables adaptive learning and supports different types of materials.
- Learning design includes measurement rubrics and quality control.

While this is all very exciting and captures most of what will be necessary in a vision for moving education forward, I feel the NGDLE framework is still missing a few key elements.

From Lego to Central Nervous System

The core analogy used in the NGDLE paper is that each component of the learning environment is a Lego brick:

- The days of the LMS as a "walled garden" app that does everything is over.
- Today many kinds of amazing learning and collaboration tools (Lego bricks) should be accessible to educators.
- We have standards that let these tools (including an LMS) talk to each other. That is, all bricks share some properties that let them fit together.
- Students and teachers sign in once to this "ecosystem of bricks."
- The bricks share results and data.
- These bricks fit together; they can be interchanged and swapped at will, with confidence that the learning experience will continue uninterrupted.

While the Lego approach would be an amazing technical feat, the issues that stop most instructors from using even the intermediate capabilities of the "one-size-fits-all" LMS would be magnified with such a system. It's hard to imagine instructors both constructing a new mash-up environment and crafting improved learning activities. Any "next-gen" attempt to completely rework the pedagogical model *and* introduce a "mash-up of whatever" to fulfil this model would fall victim to the same criticisms levied at the LMS today: there is too little time and training to expect faculty to figure out the nuances of implementation on their own.

To find a more appropriate analogy, let's back up to some arguable requirements for a next-gen student experience. Because to paraphrase the NGDLE paper, learning isn't simple

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or complicated—it's complex. And this complexity is the reason the creators of systems like the LMS—not the instructor—need to intelligently orchestrate all these different "bricks" to serve the student. We cannot leave it to instructors to be LMS, content, and pedagogical experts. We need to give them a ready-made, but flexible, system.

The Lego metaphor works only if we're talking about "old school" Lego design—bricks of two, three, and four-post pieces that neatly fit together. Modern edtech is a lot more like the modern Lego. There are wheels and rocket launchers and belts and all kinds of amazing pieces that work well with each other, but *only* when they are configured properly. A user cannot simply stick together different pieces and assume they will work harmoniously in creating an environment through which each student can be successful.

An additional analogy can better describe the NGDLE: the LMS needs to be a *central nervous system* that connects the components (the bricks) in a unified learning ecosystem. And the NGDLE nervous system needs to understand, at a minimum, the learning outcomes, the learner assessment, the learner record, and how to launch the right learning moments.

What's Possible?

Once we have an LMS that understands learning, it could help instructors construct advanced learning pathways that connect the bricks to support improved learning experiences and outcomes. Just as in our personal lives we need a core system that is a flexible way to get things done and intelligently coordinate all our activities, the hub coordinates different systems, which talk to each other.

To accomplish these improved learning outcomes, we need to purposefully design learning experiences that are personalized to a student and are highly engaging—and the most natural place for this to occur is in the LMS. People will not, and cannot, do this alone. Technology is needed to make it feasible to do this at scale. As the NGDLE paper states:

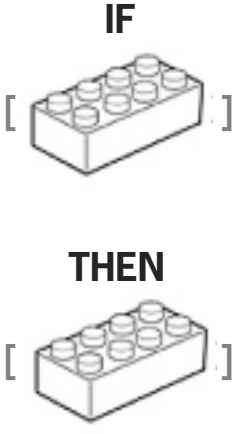
To accomplish these improved learning outcomes, we need to purposefully design learning experiences that are personalized to a student and are highly engaging—and the most natural place for this to occur is in the LMS.

"Despite the high percentages of LMS adoption, relatively few instructors use its more advanced features—just 41% of faculty surveyed report using the LMS 'to promote interaction outside the classroom.'"

Viewed from a workflow coding perspective, it would go something like this:

- IF [Student chooses "Project Option" as assignment1] THEN [Release assignment folder, and project instructions, schedule project draft review meeting]
- IF [Student hasn't read content1 by Wednesday] THEN [Send reminder to student with links to content1]

Or more generally, the LMS would connect the Lego bricks, similar to how the workflow engine would draw its recipes:



These examples are very basic; what's important is that they are practical. Having an LMS working as a central nervous system in this manner encourages practices like mastery-based feedback, timely and personalized communication, student choice in expression and activity, authentic assessment, and self-regulation.

The process of articulating, supporting, nurturing, demonstrating, and evaluating learning outcomes is, of course, far more complex than a series of simple "If/Then" statements. But this is what the next generation LMS is good at: being a central nervous system—or learning hub—through which a variety of learning activities and tools are used. This is also where the LMS needs to go: bringing together and making sense of all the amazing innovations happening around it. This is much harder to do, perhaps even impossible, if all the pieces involved are just bricks without anything to orchestrate them or to weave them together into a meaningful, personal experience for achieving well-defined learning outcomes.

We Have to Get "IT-Less"

I travel the world talking to educators, data scientists, administrators—and everyone in between. Everywhere I go, I hear the same thing: "If new tools didn't require so much IT time, data exports, and integration, we might actually have some time to help our faculty design an amazing student learning experience. But it's so complicated!"

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Our contribution toward the NGDLE vision is a next generation learning system designed to create great learning experiences that improve learning outcomes. It will let faculty and students use the tools they love.

I think it's up to the edtech community, particularly LMS vendors, to give IT and instructional support staff more time. They can do so by being better partners:

- Making a commitment to build easy, flexible, and smart technology
- Working with colleges and universities to remove barriers to adopting new tools in the ecosystem
- Standardizing the vetting of accessibility compliance (the Strategic Nonvisual Access Partner Program from the National Federation of the Blind is a great start)
- Advancing standards for data exchange while protecting individual privacy
- Building integrated components that work with the institutions using them—learning quickly about what is and is not working well and applying those lessons to the next generation of interoperability standards
- Letting people use the tools they love and providing more ways for nontechnical individuals (including students) to easily integrate new features into learning activities

Many of these recommendations have to do with how a vendor builds a relationship with customers, though others rely on the community of vendors organizing around standards and breaking down accessibility barriers.

Open standards have a long way to go before they can become the frame for the NGDLE vision, but they're getting closer every day. I have seen amazing work being done to further the vision of the NGDLE in the last two years. Two examples are the IMS Global Learning Consortium's Learning Tools Interoperability (LTI) Content-Item Message and Caliper, both of which are starting to show their promise. They are critical to allowing us to move beyond a simple integration of apps and leaving the data behind, to the ability to launch a third-party tool and get the data, context, and results back. The ability to easily record and analyze the learner record and activities is very valuable from an instructional perspective.

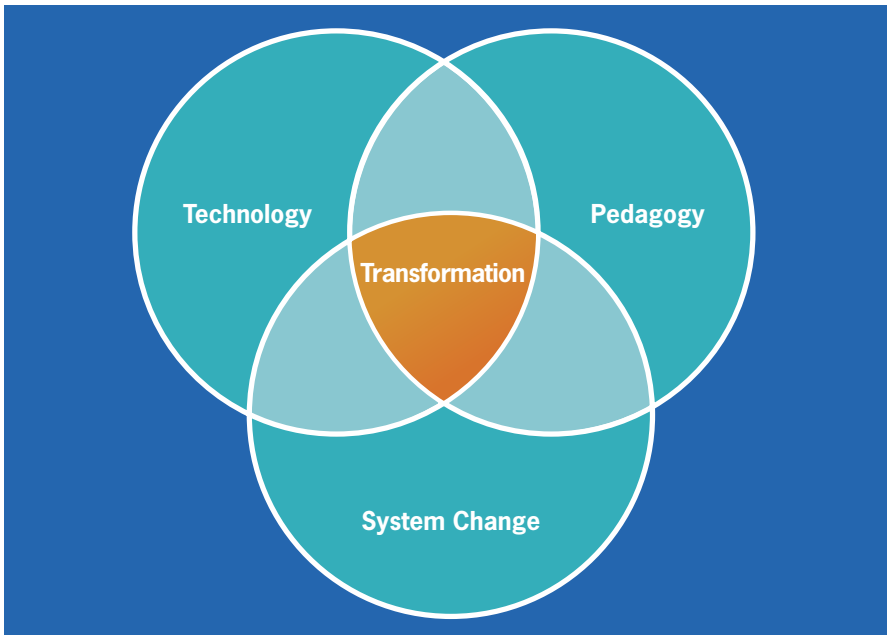
Even with these pieces in place, we still need to think about the experience for the student. Consistency as the learner moves between apps and services must be preserved. But that's all very technical edtech work. The real excitement of the NGDLE is found in rethinking the experience through the lens of what humans need rather than what technology can do.

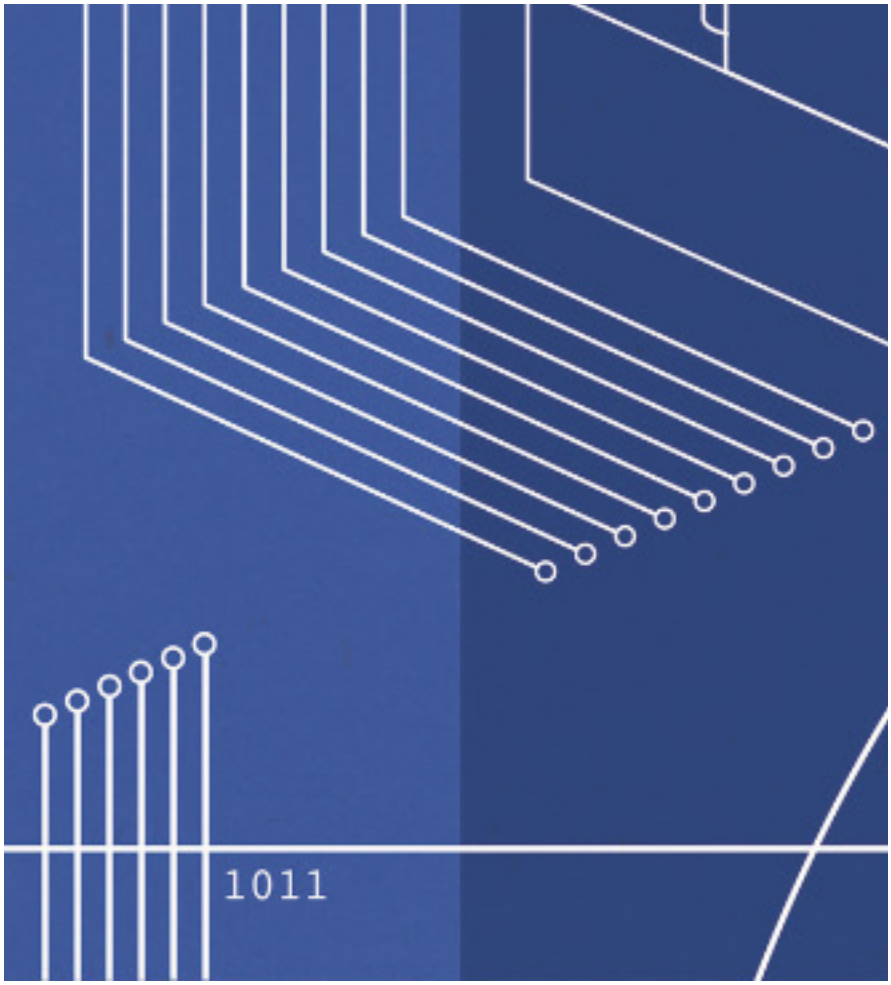
Humanizing the NGDLE: Universal Design for Learning

One of the key lessons I've learned in building edtech is that real results require three ingredients to be transformational: technology, pedagogy, and system change (see figure 1).

Technologists are often very focused on the technology, but the reality is that the more deeply and closely we understand the pedagogy and the people in the institutions—students, faculty, instructional support staff, administrators—the better suited we are to actually making the tech work for them.

Figure 1. Ingredients for Transformation





When designing products, most software companies today take a human-centered approach, with empathy for the user being central to developing design goals. With this in mind, the question of "what will the next generation learning management system look like?" may be the wrong question. We need to ask other questions as well. For example: "How will this next generation learning management system improve learning outcomes for all students?" Critical to this question is the use of "students," plural. There is not one mythical "average" student. Each student is different, unique, and capable of succeeding when given the right chance.

I applaud the discussion in the NGDLE paper about Universal Design for Learning (UDL). This is a model that encourages us to design learning environments, content, and services that systematically remove the barriers to success for our students. It seeks to provide multiple ways for students to consume information, to express ideas, and to engage. It is how we purposefully design a learning experience to reach every learner—something we should all be striving to achieve.

The impact of the NGDLE paper is huge. I've personally seen it impact the development of next generation learning models, such as the Macy Foundation paper on the future of the Health Professional Education. The NGDLE framework is now a regular part of conversations with executives at various universities and colleges, and I've seen it used as the measure of fit in several LMS selections. More and more, institutions are turning to partners to help them transform and realize their vision for student achievement through technology.

As the president and chief executive officer of an edtech company known for its LMS, I believe that our contribution toward the NGDLE vision is a next generation learning system designed to create great learning experiences that improve learning outcomes. This learning system will understand learning outcomes, learner assessment, the learner record, and how to launch the right learning moments for each student. It will be based on UDL, with flexibility and actionable data embedded in its core workflows. It will support standards and interoperability. It will let faculty and students use the tools they love. This is an exciting path forward in achieving the NGDLE vision in a way that can be practically applied by today's instructors and used for the benefit of all learners.

Finally, we all need to continue to focus on building learning experiences that deliver real results: improving adoption, strengthening learning outcomes, increasing retention, lifting engagement, enhancing learner satisfaction, and making our time more productive. ■

Note

1. Malcolm Brown, Joanne Dehoney, and Nancy Millichap, *The Next Generation Digital Learning Environment: A Report on Research*, an EDUCAUSE Learning Initiative (ELI) white paper (April 2015).

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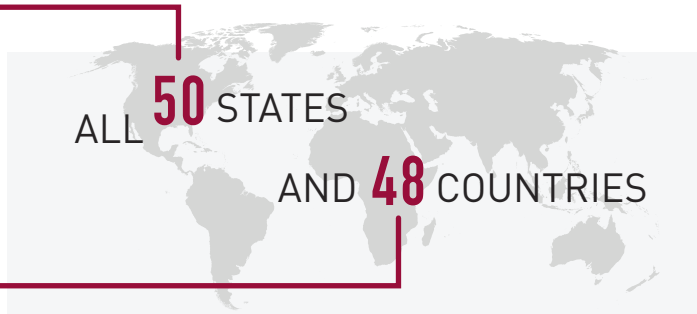

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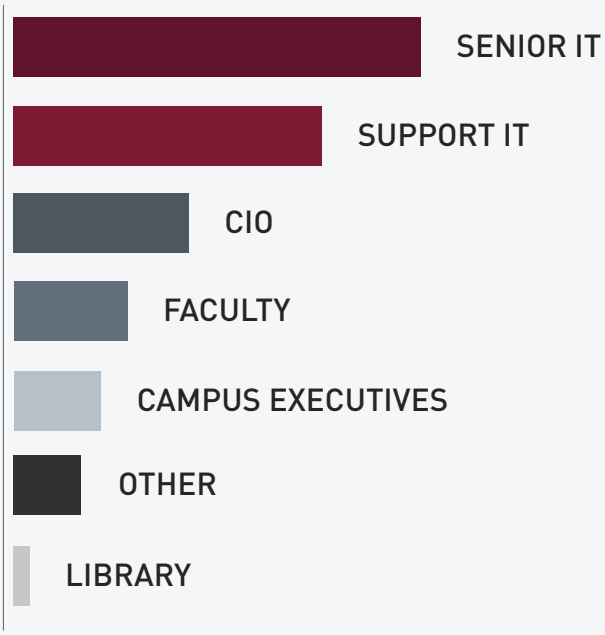

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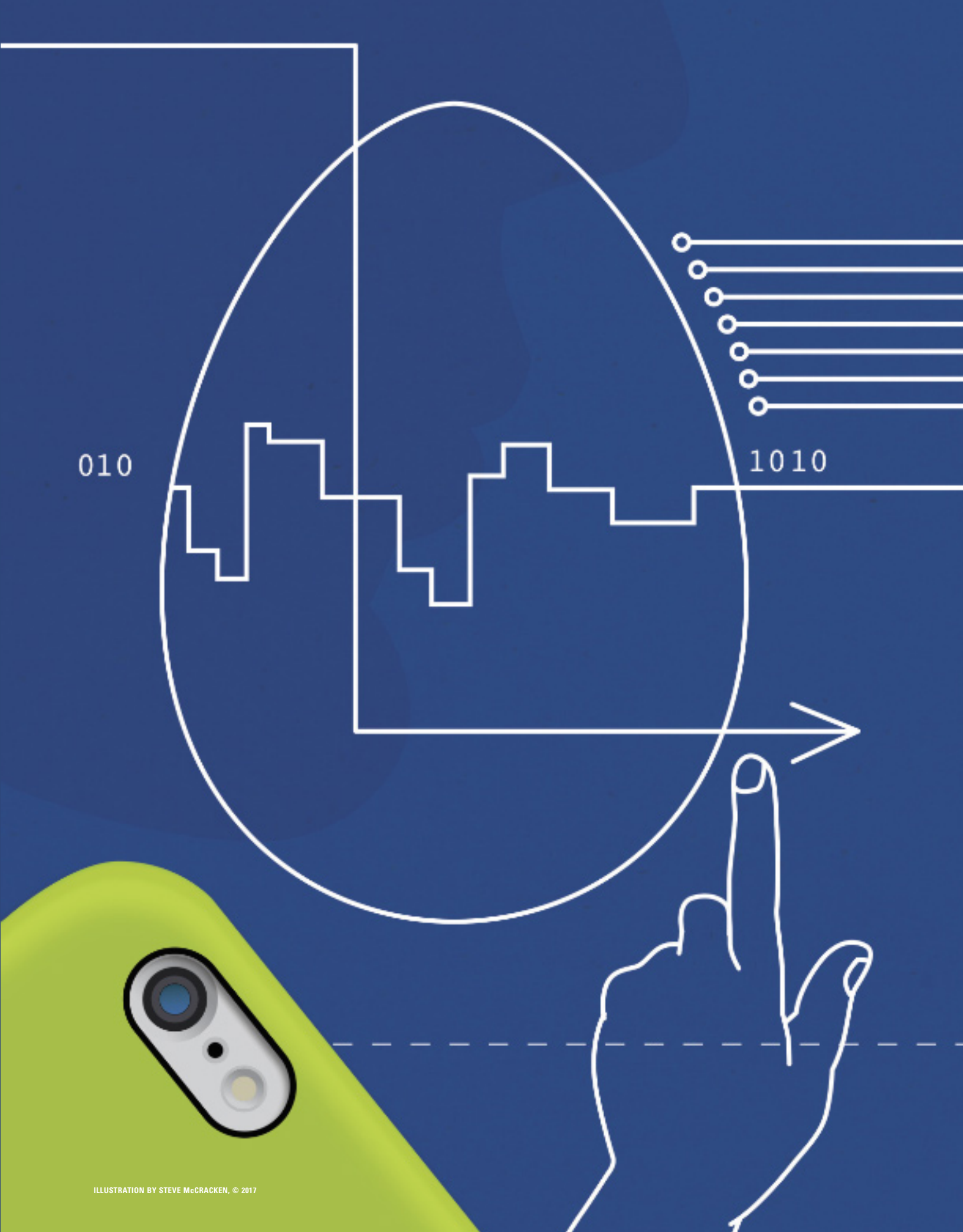
What Is the Next Generation?

Michael Feldstein

When people use the phrase "next generation," they often mean something as vague as "better than what we have now." The EDUCAUSE Learning Initiative used the phrase in its 2015 paper *The Next Generation Digital Learning Environment: A Report on Research*.[1] The title begs certain questions. Next generation of what? What have been the generations so far? What defines a shift from one generation to the next? What drives that shift? These are important questions to answer if we want to see our digital learning environments evolve quickly and in a particular direction. We need to understand what evolution means and how it happens.



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In the definitions section of the report, the authors' description of what they mean by "next generation" includes the following:

> We have adopted the term *next generation digital learning environment* (NGDLE) for what should come after the LMS [learning management system] era. The term pulls together several key themes. What comes next must be informed by the new learning-centered model that increasingly characterizes higher education practice (hence *next generation*). It must of course be digital, given that digital technology has become a component of virtually all teaching and learning practice. It must be about learning, since learning ties together learner and instructor. Finally, it must be an environment or ecosystem—a dynamic, interconnected, ever-evolving community of learners, instructors, tools, and content.

These ideas—a digital learning environment that is focused on learning (rather than administration) and is modular to accommodate different pedagogical needs—are not new. There are some specifics in the paper that address details that update the concept based on recent developments such as the growth of learning analytics, but the basic idea of a "next generation LMS" or "post-LMS" that is modular enough and pedagogically focused enough to feel like a generational shift has been around for over a decade now.

I was involved with one effort to promote these principles at the State University of New York (SUNY) back in 2005.[2] We failed—by which I mean that we did not gain enough traction to persuade SUNY to fund the system. Since then, I have seen various incarnations of the idea come and go. LMSs have made some progress toward these goals through the incorporation of integration standards like the IMS Global Learning Consortium's Learning Tools Interoperability (LTI). But the progress hasn't yet amounted to the kind of holistic step-function change that EDUCAUSE is calling for in the NGDLE framework or that others have called for in the past, even though the idea seems popular enough and evergreen.

This is not to say that the LMS has remained in complete stasis for the past twenty years. There *have* been several inflection points that could be described as "generational" changes. If we want to drive an *intentional* generational change, then it's worthwhile to look back at the evolution of the LMS, how one might define the generational changes that have happened so far, and what the drivers for those changes have been. Perhaps we can learn how to be more effective at catalyzing change in the learning platforms that are available to us.

The First Three Generations

I would argue that we are in the third generation of the LMS. The first generation started in the late 1990s (see figure 1), when the first commercialized purpose-built LMSs for higher education began to appear. With the dawn of modern networking, colleges and universities that were interested in distance learning began to see new opportunities. Some started sharing files and having discussions with pre-web internet tools like FTP, Gopher, and bulletin board systems, or they experimented with generic groupware like Lotus Notes.

At their heart, early LMSs had the same basic features as the technologies that inspired them: the ability to share files and to have discussions. They had some minor enhancements. For example, a homework drop box is a file-sharing tool with special permissions that a generic file-sharing tool wouldn't have. The announcements page is a little like a special bulletin board thread. There would occasionally be a tool that fell outside of this paradigm, like a simple quiz or survey tool. But basically, the first-generation tools were adaptations of the generically available tools intended to make various basic communication and file-sharing tasks simpler for teachers and students.

According to EDUCAUSE data, about 90 percent of U.S. colleges and universities had an institutionally supported course management system by 2003.[3] We can consider this year to be the start of the second generation of the LMS. During the period from about 2003 to about 2010, the main *functional* changes in the product were to add a couple of more complex education-specific tools. In particular, gradebooks and testing tools took up a huge percentage of available developer resources for any given LMS at that time. These two applications together can easily comprise more than half the total lines of code in each LMS. So the second generation was all about adding testing and grading functions to the file-sharing and discussion functions, with some decoration of specialty add-ons around the edges. For example, at least several LMS development teams created blogging applications, which never really caught on as a popular feature for the product category.

During this period, the LMS was very often treated as a transactional course administration system, particularly for on-campus classes. Teachers would post syllabi, announcements, and grades. Students would turn in papers. They might have discussions or take quizzes, but both of those uses were (and still are) minority cases. And many faculty members didn't use the LMS at all. Even though every institution had one, most classes either didn't use the LMS or used it roughly the same way one might use Dropbox today. The exceptions were

Figure 1. LMS Market Share for U.S. and Canadian Higher Ed Institutions

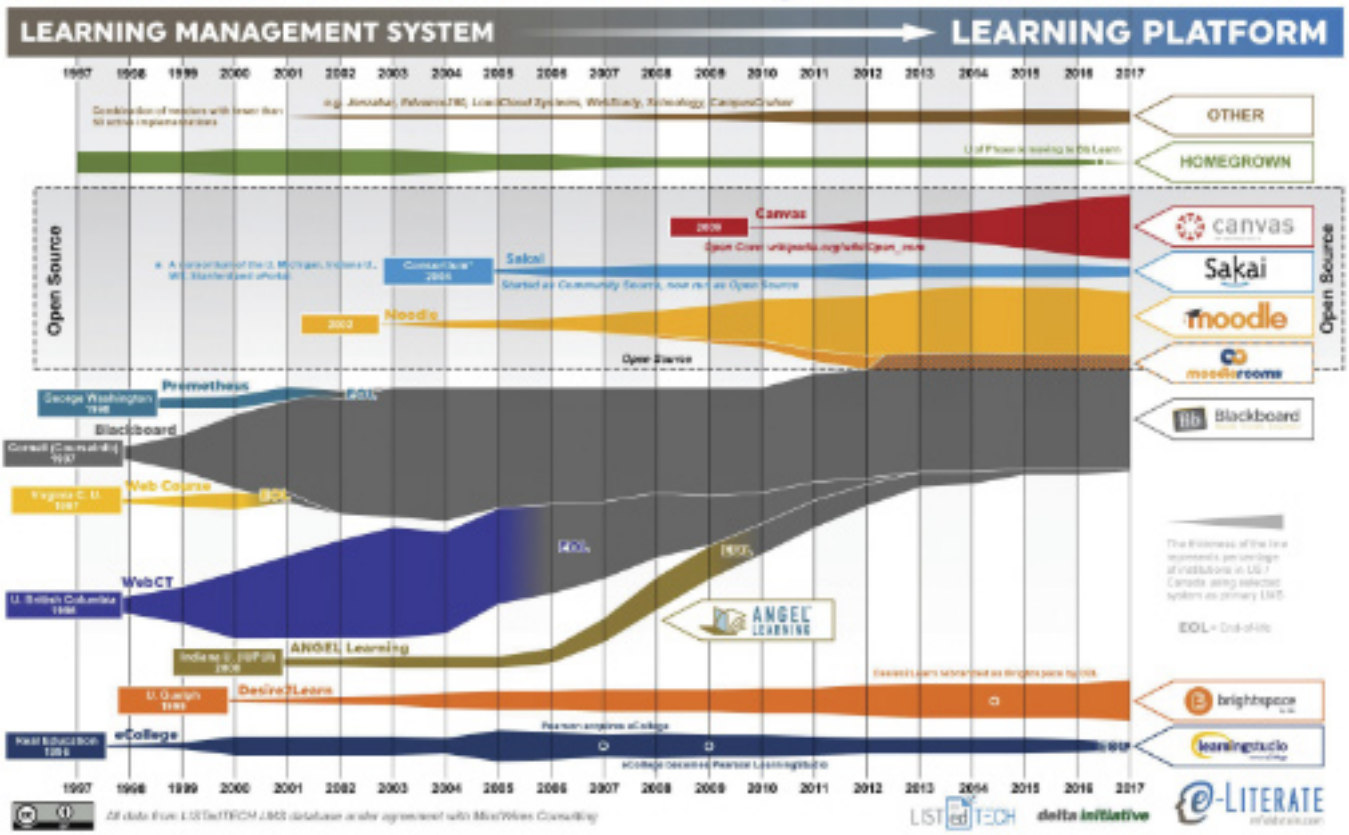
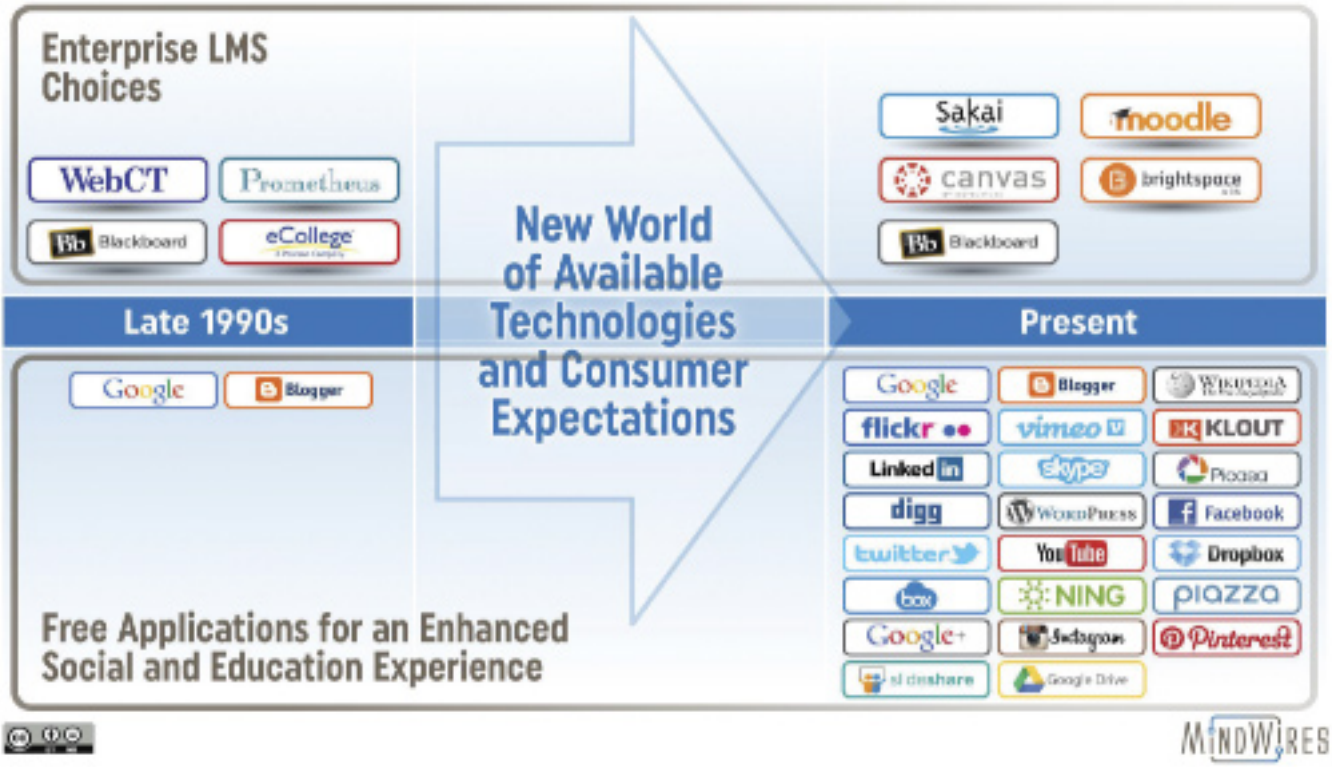


Figure 2. The Growing Digital Ecosystem



colleges and universities that ran significant distance learning programs, which at that time were mostly access-oriented institutions like community colleges and for-profits trying to reach working adults. To the degree that there was innovation in the second generation beyond grading and testing, it was largely driven by these institutions.

Then a few interesting things happened around 2010 (give or take a year or two), leading to what I would argue is the third generation of the LMS. First, IMS Global came out with the next generation of its Learning Information Services (LIS) standard. An LMS isn't terribly useful until it has information about which students are in which classes. That information is generally imported from the student information system, which is the class registration system of record. Before LIS, colleges and universities often had to develop custom software to transfer the data, directly overseen by an IT staff member as a full-time job in larger institutions. LIS made it possible not only to reduce that regular maintenance labor but also to switch from one LMS to another without incurring custom integration costs.

The second thing that happened is that IMS Global came out with its Learning Tools Interoperability (LTI) standard. LTI made it possible to integrate many specialized tools created by third-party developers into any LMS. Because tools built to this standard could now be integrated with any compliant LMS and therefore sold to more higher education institutions using more LMSs without requiring additional integration development for the app developers, the number of specialized educational tools proliferated (see figure 2).

The third thing that happened in the same period is that Instructure Canvas hit the market. The product had a few important differentiators, including technological differentiators like a cloud-native architecture, but the most important for our current purpose is a strong emphasis on ease of use. There is no question that Canvas has strongly influenced the market with its success, driving competitors to work harder at making their applications easier to use.

To sum up, during the period from about 2010 to now, moving from one LMS to another became easier, class spaces within the LMS became simpler to populate with specialty tools for particular kinds of educational interactions, and ease of use began to improve significantly. During this same period, LMS adoption patterns have changed. More colleges and universities are willing to look around and seriously consider switching more regularly. When institutions do switch, we are seeing quicker faculty uptake as well as broader and deeper use, including for on-campus courses. The LMS is being seen by increasing numbers of faculty members as an important learning environment that is essential to their teaching. And more institutions of all shapes and sizes are developing significant distance-learning programs. It is no coincidence that faculty involvement in LMS selection

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All of the pieces have to come together in order to drive a step-function change toward digital learning environments that are holistically learning-focused.

processes has increased tremendously during this same period.

What This Means for the Next Generation

During the previous generational shifts, the LMS and the interoperability standards that support the product category coevolved with usage patterns by individual instructors and with procurement practices by institutions. Customer demand and platform capability drove each other in a virtuous cycle that led to a step-function change in the product design.

Are the forces in place to drive the changeover to a next generation right now? That's the key question for the NGDLE framework. If they aren't, then NGDLE will die on the vine, regardless of the merits of the vision. I don't know the answer to that question, but I do see a few positive signs:

- On the platform side, we are beginning to learn how to analyze student behavior patterns in the learning environment—which, thanks to LTI, extends well beyond the LMS in many cases—and we are beginning to see patterns that enable us to provide better support to students. LMS vendors as well as third-party companies are beginning to compete on this capability.
- At the same time, institutions—especially public colleges and universities, as well as for-profits—are increasingly seeing their funding tied to improving student outcomes. So there is a widespread and urgent interest in using the learning environment as a tool for supporting those improvements.
- We are also starting to see cases like the California Community Colleges Online Education Initiative (OEI), which uses both faculty involvement in the LMS procurement process and business drivers such as over- and underenrolled classes to foster deeper collaboration between campuses and stronger professional development designed to help faculty learn skills that can enable them to be more effective teachers.[4]

All of the pieces—the products and the interoperability standards, the educator demand, and the institutional procurement processes—have to come together in order to drive a step-function change toward digital learning environments that are holistically learning-focused and capable of being tailored by educators and students to meet the specific educational needs of the moment. For those who want to see that shift happen, it will be important to attend to every one of these factors. The most effective places to do this work often aren't in magazine articles or conference talks. They are in deeply unsexy places like technical interoperability standards meetings or on LMS selection committees. For example, IMS Global's relatively new Caliper Analytics standard could be an incredibly powerful aid in achieving the aims of the NGDLE vision. But before that will happen, vendors need to hear that their customers know enough and care enough about the implementation of the standard to influence their product-adoption decisions. That, in turn, involves not only becoming familiar with the standards process and the differences in vendor implementations but also educating an institution's LMS selection committee members regarding the value of the standard and persuading them to prioritize it as a capability that influences their recommendations. Real change is often hard because the work involved is boring and obscure and requires a command of arcane details.

If we want a next generation digital learning environment, then we'd better be ready to roll up our sleeves and get our hands dirty. ■

Notes

1. Malcolm Brown, Joanne Dehoney, and Nancy Millichap, *The Next Generation Digital Learning Environment: A Report on Research*, an EDUCAUSE Learning Initiative (ELI) white paper (April 2015).
2. Michael Feldstein, "LMOS Services and Service Brokers, Part I," *e-Literate*, October 23, 2005.
3. Brian L. Hawkins, Julia A. Rudy, and Joshua W. Madsen, *EDUCAUSE Core Data Service: 2002 Summary Report* (Boulder, CO: EDUCAUSE, 2003), 31.
4. Phil Hill, "The Intended Consequences of California's Online Education Initiative," *e-Literate*, January 8, 2017.

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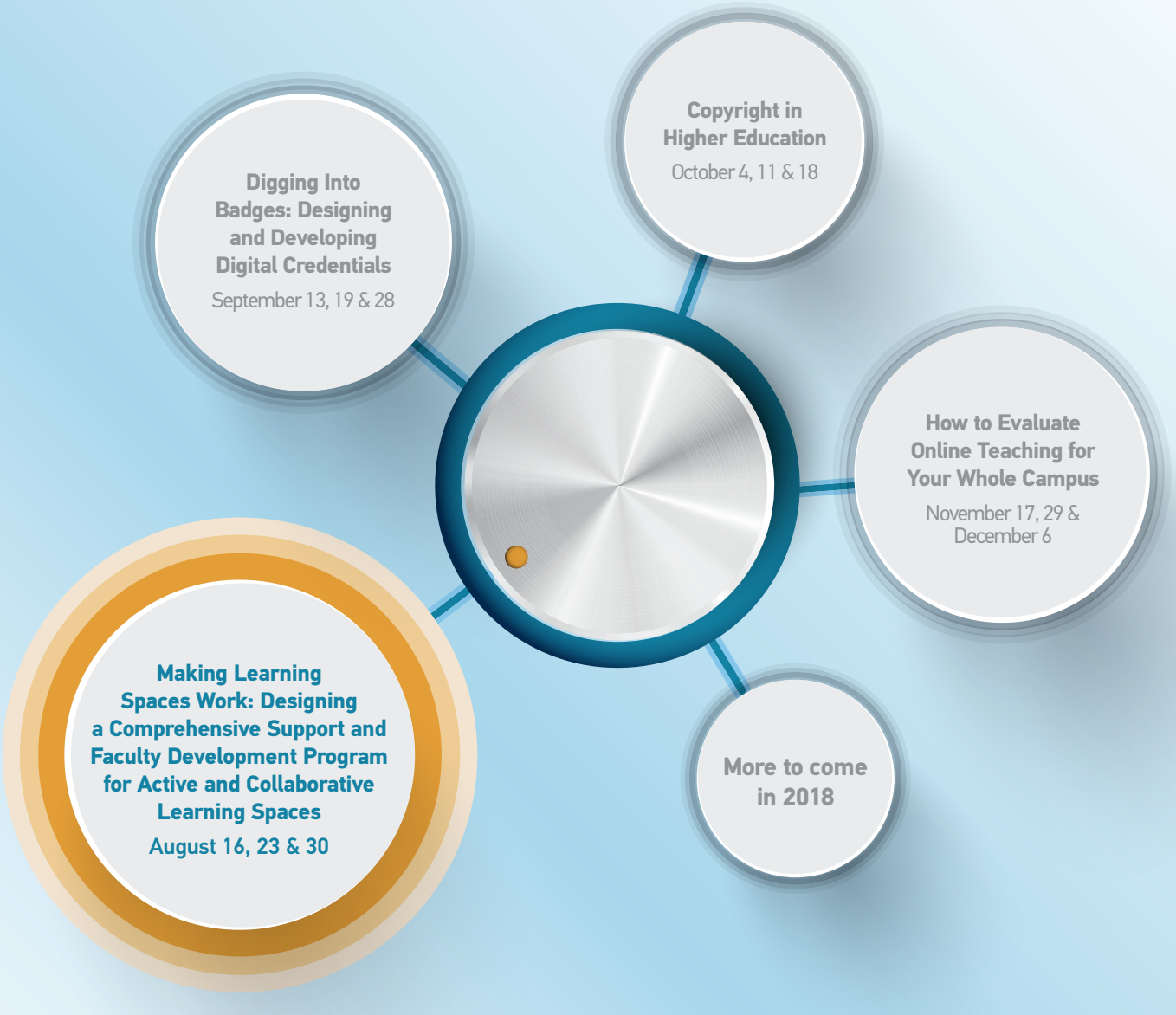

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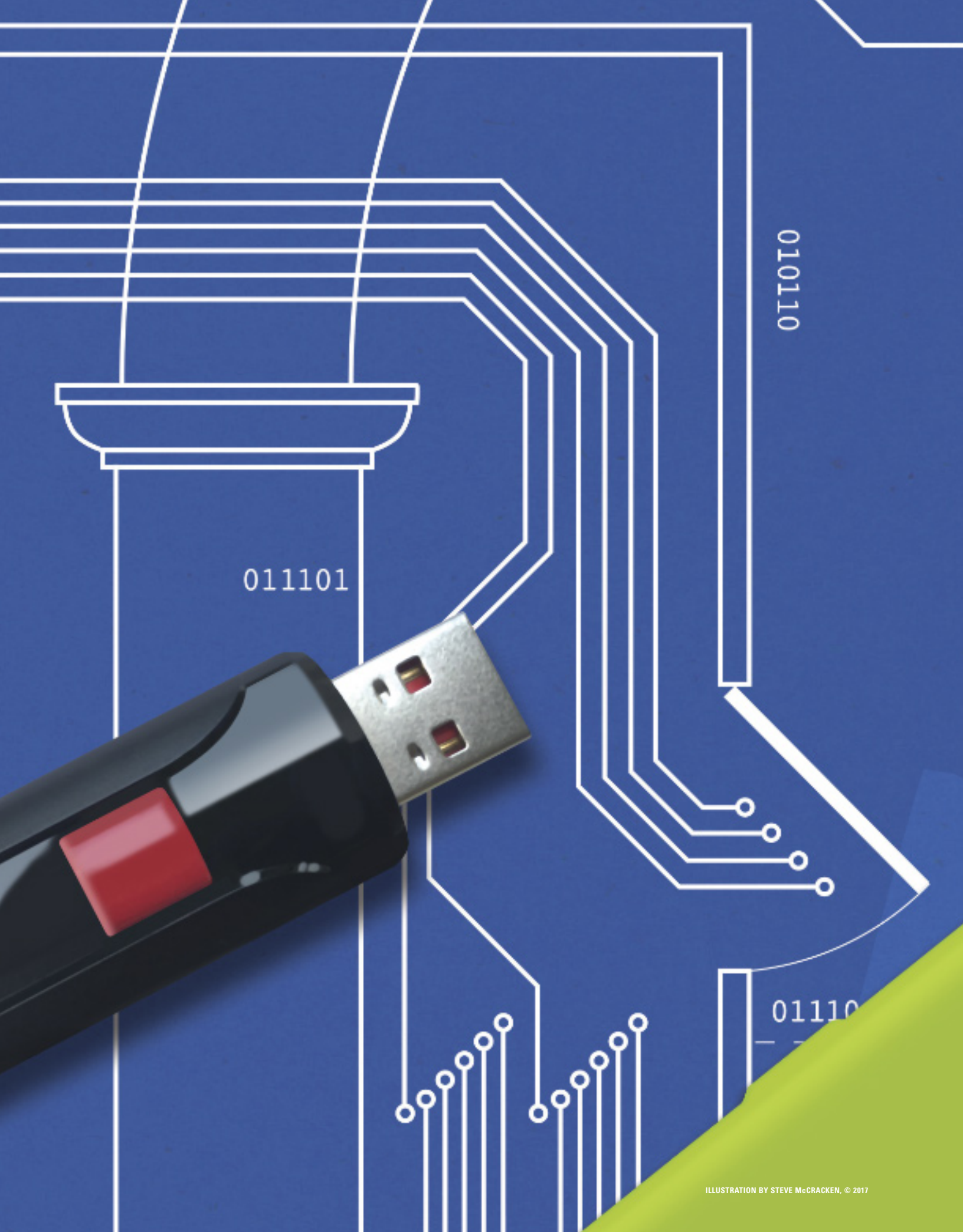

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Tearing Down Walls to Deliver on the Promise of Edtech

Stephen Laster

As the chief digital officer for McGraw-Hill Education, I have hardly a minute in my day when I'm not thinking about educational technology (edtech). Often, that means I'm focused on solving a particular problem or making incremental progress on a project. But I also spend a good deal of time reflecting on the bigger picture: the true human impact that edtech can have, the progress that our industry has made in the past decade, and the work that we still have ahead of us.

I've worked in the higher education technology space since the early 2000s—first as the head of Curriculum and Technology Innovation for Babson College and then as the chief information officer for Harvard Business School before joining McGraw-Hill Education. As I've watched the sector evolve and mature, I've been struck both by how transformative edtech has been in higher education and by how much room we still have for improvement. If I were to give the edtech industry a grade—channeling the former software-design instructor in me—I would give us a solid "B."

So how can we bump our performance up to "A" quality? What does the ideal future of postsecondary edtech entail? On a practical level, some of the best insights and guidelines come from forward-looking research projects such as the EDUCAUSE next generation digital learning environment (NGDLE) framework. But before we discuss those specific insights and guidelines, it's worth quickly exploring one of the "bigger picture" concepts that I mentioned earlier: the true purpose and human impact of edtech.

Will we embrace the NGDLE in its entirety and support it with a robust implementation of interoperability standards?

The Fundamental Promise of Edtech

In 1984, Benjamin Bloom published a seminal piece of learning science research called "The 2 Sigma Problem."[1] The research explored the effects of three different instructional environments on students' ability to learn: a conventional classroom environment; a "mastery learning" environment, where students received personalized feedback and support based on formative assessments; and a tutor-supported mastery learning environment. The results definitively demonstrated that students in a mastery learning environment significantly outperform those in conventional environments and that those with tutorial support perform even better.

These findings might sound obvious today—and indeed, they now inform how virtually every modern classroom and learning solution is structured, especially as technology has allowed us to improve personalization for every student. But it's vital to understand just how groundbreaking this research was at the time—and how truly invaluable the latest learning research continues to be today.

Too often when we talk about edtech we focus on the "tech." The only way that edtech can truly be impactful is if it's focused on solving real, concrete educational challenges, identified through research. Great edtech should fade into the background, solving problems and supporting authentic learning and teaching experiences without ever drawing attention to itself.

But that kind of great edtech can't be created in a vacuum. It needs to be developed collaboratively, in an open environment involving researchers, course designers, faculty, and technologists from across the sector, each contributing his or her expertise toward a common cause: developing solutions that seamlessly, effectively, and efficiently achieve research-based goals.

So what are the most pressing research-based goals for higher education today? What should the next generation of higher education digital learning environments look like?

A Shared Worldview

EDUCAUSE provided a powerful framework for rethinking what digital learning environments should look like in its April 2015 ELI white paper on the NGDLE. Malcolm Brown, Joanne Dehoney, and Nancy Millichap wrote: "Higher education is moving away from its traditional emphasis on the instructor [and] replacing it with a focus on learning and the learner. Higher education is also moving away from a standard form factor for the course, experimenting with a variety of course models. These developments pose a dilemma for any [learning management system] whose design is still informed by instructor-centric, one-size-fits-all assumptions about teaching and learning."[2]

If higher education is changing, the technology that supports it needs to change as well. The technology systems that colleges and universities have used for the last two decades need to be "supplemented (and perhaps later replaced) by a new digital architecture and components for learning that contribute to and enable the transitions that higher education is currently experiencing."

Here's how the white paper describes an NGDLE ecosystem:

- *The implementation will be a confederation of IT systems,* including content repositories, analytics engines, and a wide variety of applications and digital services.
- *One key to making such a confederation work will be full adherence to standards* for interoperability, as well as for data and content exchange.
- *Instead of uniformity and centrality, it will need to support personalization* as an option at all levels of the institution. The NGDLE will not be exactly the

same for any two learners, instructors, or institutions.

- *For users, it will be a cloud-like space* to aggregate and connect content and functionality, similar to a smartphone, where users fashion their environments directly with self-selected apps.
- *If the paradigm for the NGDLE is a digital confederation of components, the model for the NGDLE architecture may be the mash-up.* A mash-up is a web page or application that "uses content from more than one source to create a single new service displayed in a single graphical interface."[3] Hence it uses a heterogeneity of components to produce a homogeneity of function. The confederation-based NGDLE will be mashed up at both the individual and the institutional levels, as opposed to consortia forming to create open enterprise applications.

The overarching theme? Everything must be open. If the promise of and the investment in edtech are truly going to transform outcomes in this new higher education world, they have to be delivered in a seamless, open ecosystem that prioritizes flexibility over structure and in which institutions have the freedom to construct learning environments that are central to their mission.

From Framework to Fulfillment

Whereas the NGDLE framework gives us our template, we'll need industry-wide interoperability standards—and a robust implementation of those standards—to realize the full impact of open.

While integration might seem to be the concern of IT departments, in truth it has serious implications for teaching and learning. Technologies that live within closed systems create roadblocks for students and instructors as edtech is used to accelerate learner success and faculty efficiency. The free flow of identity, rostering, and learning data, harnessed in service of confident learners and caring faculty, is what allows technology to move us along Bloom's journey toward mastery learning.

Without commitment to standards, there can be no unified ecosystem, no flexibility for institutions, and no realization of the principles outlined by the NGDLE framework. The simple yet challenging solution is to support technology standards set forth by organizations such as the IMS Global Learning Consortium (https://www.imsglobal.org/) and to support edtech providers who authentically implement the standards. Building digital content and learning technology around open standards ensures that educators and students can determine what is most effective without worrying about whether different technologies will work together.

The true accelerator toward the NGDLE's world of choice is the virtuous cycle of institutions and faculty demanding the implementation of standards in their procurements of edtech and the commitment of edtech vendors doing their best work to make standards-based integration a core capability of their offerings. The good news is that we're starting to see this in action. Institutions like Arizona State University and Georgia Tech are embracing learning solutions that bring several providers together, each offering its best contributions and all working together through seamless integrations. In these programs, the costs of course design and delivery have gone down as the quality of teaching and learning has gone up.

As I view it, we in higher education stand at a profound moment of choice. We have a framework, we have standards, and we have the need to greatly enhance the impact of edtech on learning outcomes. Now the choice before all of us in the community is to decide which path to take. Will we simply acknowledge the NGDLE as a helpful framework and go about our business as usual? Or will we embrace it in its entirety and support it with a robust implementation of interoperability standards?

Moving Forward

As I consider what I can personally do, and what we can all do, to accelerate down the NGDLE path, a few concrete steps occur to me. In the spirit of iteration, they primarily involve small, community-centric actions:

- In procurements, include an adherence to open standards as a requirement.
- Rather than building software connectors designed to support only a particular campus or product, contribute software connectors (and shims) to the community, enabling legacy systems to talk to open systems.
- For standards that could be improved, get involved and shape their implementation.
- Take the time to document successes in creating an NGDLE, and share the documentation with the higher education community.

The full implementation of the NGDLE framework is hardly the easier path, but I'm confident that taking it—and taking it decisively—will make all the difference. Doing so not only will allow us to cement the powerful role that technology can play in solving our efficiency and effectiveness issues but also will enable us to achieve an immensely positive impact on education at large. ■

Notes

1. Benjamin S. Bloom, "The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring," *Educational Researcher* 13, no. 6 (June–July 1984).
2. Malcolm Brown, Joanne Dehoney, and Nancy Millichap, *The Next Generation Digital Learning Environment: A Report on Research*, an EDUCAUSE Learning Initiative (ELI) white paper (April 2015).
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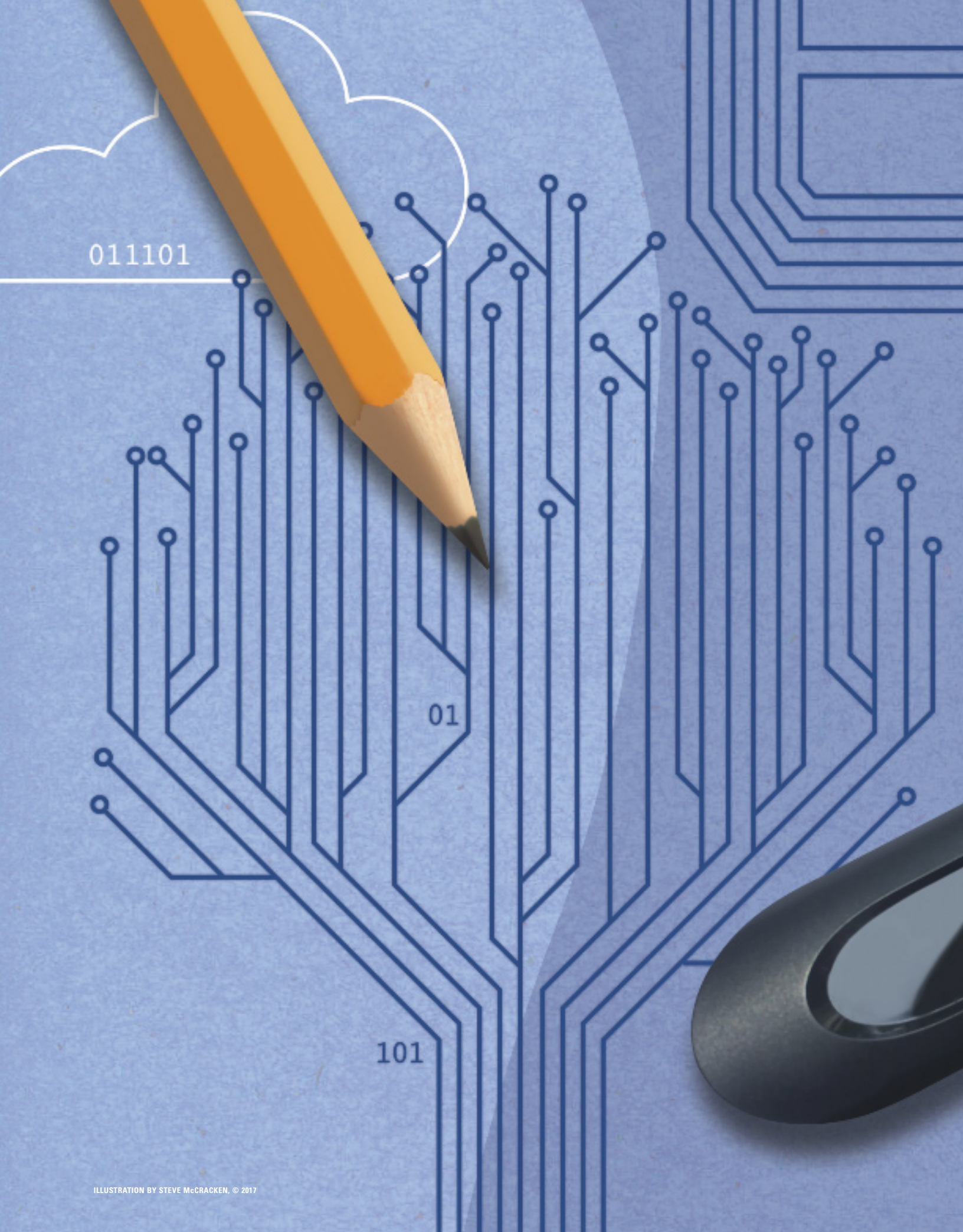
The Origins of Innovation in the Edtech Ecosystem

Vince Kellen

The learning management system (LMS) as we have known it is fading in its importance. Supplanting it are hundreds of tools and innovations, created by a plethora of vendors, institutions, students, and instructors in a frothy, bubbling world known as the edtech ecosystem. If the pace of innovation and experimentation persists, this could change instruction for the better. However, this transformation will not come about in the manner that many experts and pundits have predicted. Furthermore, IT leaders and chief information officers (CIOs) will need to dig in now and start contributing.



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The word *ecosystem,* borrowed from its ecological and biological roots, here refers to the educational technology (edtech) market. This market is now sufficiently complex, with dynamic and constantly evolving interconnections between all participants: the edtech vendors themselves; their customers (educational institutions and students); investors in the market; industry trade groups; analysts; local, state and federal governments; think tanks; and vendor suppliers, including companies—like Amazon, Microsoft, and Google—that offer cloud infrastructure and software development tools. This market is diverse with participants big and small, players who have been deeply embedded in higher education for a long time as well as recent interlopers who are feeling their way. The relationships between the various players change over time and are often murky. For example, the largest edtech vendor today may be Amazon. So many edtech vendors have created their solutions in the Amazon environment that it is likely students, faculty, and staff find their digital interactions flowing through the Amazon platforms more often than in any other platform.

Unfortunately, the market and many IT leaders have mischaracterized IT tools, causing them to underestimate the importance of an ecosystem approach. In addition, external conditions, most noticeably the calls for improvements in teaching from our citizen stakeholders and now from many edtech vendors, continue to influence the ecosystem. In both cases, action from CIOs and IT leaders can help.

The Deeper Nature of IT Tools

Unlike all the tools that have come before, IT tools are much more malleable, almost obscenely so. Timeless tools like the hammer and the saw are made for a specific purpose and require just a bit of practice to master. The capabilities of other tools like the bow and arrow, the atlatl, and the sword become greatly enhanced with advanced skill, requiring dedicated and effortful practice. While designed to work with the human body, these tools still require that people change their behavior and their physical skill to adapt to the tool.

IT tools are quite different. They usually require little to no physical practice to master. While we spend a modicum of physical effort to learn how to hold, type, or otherwise physically handle these tools, we spend much more time in mental effort. We must learn what each tool, each component, each icon, each link, and each button does. We have to learn how very different parts of the software relate to each other. And we need to practice the mental routines needed in order to make good use of these software tools. Over time, this mental rehearsal, just like the physical one, improves our skill.

Unlike conventional tools, IT tools are not delivered in a fully completed form. All of them require some level of modification, configuration, or customization. The inherent pliability of software almost begs for this. In today's software tools we have all sorts of customization capabilities ranging from simple to elaborate settings; we can even go as far as writing code ourselves or mashing up a collection of smaller software tools.

Since the worlds we build as educators are mental worlds with tremendous complexity, diversity, and range of ideas, our relationship with the tool is even more fascinating than the usual business functions to which software is applied. Instructors have to master this complexity in such a way as to effectively share these different worlds of ideas with learners. This complex process of matching content to learners through either automated methods or good old-fashioned face-to-face instruction beckons instructors and their attendant IT helpers to highly customize learning tools. For some difficult teaching situations, the demands that the learning task places on instructors and learners can require a great deal of tailoring. Right now and for the foreseeable future, this tailoring process is necessary for both instructors and learners. The EDUCAUSE Learning Initiative (ELI) research into the next generation digital learning environment (NGDLE) identified this need as a critical one that the market needs to address.[1]

Customizable and configurable IT tools give learners the opportunity to organize their own content and manage their own knowledge. Learners frequently invest their time into their mental scaffolding. Their tool use becomes connected to their learning and to course outcomes. This can be beneficial. When both students and instructors become facile co-creators or, at the least, co-tailors of their own tools, attachment both to the tools and to the knowledge delivered grows, building a cycle of engagement and mastery.

The richness of this emerging edtech ecosystem is spawning many thousands of micro-experiments in classrooms across the globe. While some critics may discount this seemingly endless faculty

tinkering with tools as indulgent frivolity, I disagree. Instructors are learners too. They are performance artists and have to contend with all the pressures of being on the physical or the online stage. Adopting new teaching and learning tools requires dedicated practice and tool tailoring before stepping onstage.

This tailoring yields other significant benefits. While it can facilitate learning and mastery for all involved, the configuration of these tools is enabling better data integration of learner activities or clickstreams. This in turn catalyzes rapid experimentation with learning analytics. Many vendors and leading instructional researchers are instrumenting classrooms and capturing digital footprint data for the purposes of finding ways to improve instruction. As the technology continues to evolve and undergo speciation, these instructional research insights are likely to get deeper, more focused, and highly varied across disciplines, institutional contexts, and learners. These insights will lead to the further evolution of software tools. The emerging edtech ecosystem looks poised to enable this virtuous cycle of adaption, experimentation, insights, and community sharing.

Leading Up to This Point: External Conditions

A combination of both political and technical trends has pushed us to this point. Our citizen stakeholders have been, for many years now, exhorting us to adopt business-like approaches to achieve breakthrough solutions that will deliver great results at lower costs. Partially as a result of this pressure, the edtech sector has grown significantly with dozens and dozens of startups, with some that are fabulously funded and others that had "garage band" beginnings. This most recent edtech bubble has created much interest and excitement. As one experienced edtech company chief executive officer and investor said to me: "Venture capitalists want to transform higher education because of deep-seated emotions, probably growing out of personal experience. I think they are just angry and want to reform education as a matter of personal belief." Clearly there is a lot of emotion behind the pile of money.

This hope and hype is understandable. Since the Internet, information technology has enabled new levels of coordination and synchronization across the globe, ranging from large-scale computing systems talking to each other through very-high-speed networks to an enormously large collection of small devices on the Internet chatting with each other across wired and wireless networks. Software modularity and speed of global network communication are now capable of sub-second response times. In several cases, entire industries—from travel and entertainment to retail—have been remade. Everyone likes a good story, and the come-uppance and destruction of giants through the use of a special sword is an old and appealing one. Many critics have imagined higher education as a walled fortress that, with enough scaling of the walls and battering of the doors, will also fall at the feet of IT disruption. This metaphorical overuse has led to some misplaced expectations. The mental model of information technology as a disruptive tool (i.e., a sword) has caused many participants in the ecosystem to underappreciate the co-evolutionary processes at work. In this market, both tools and tool-makers undergo intertwined incremental evolution to help solve local and collective problems.

While individual participants in the market come and go, it is this ever-evolving bundle of tool and behavior that constitutes the enduring change people seek.

We can consider the edtech market as being comprised of (a) IT constructs such as integration standards and new approaches for analyzing learning data or components like a gradebook or an in-class student response system, and (b) collections of human practices for using and configuring these constructs to deliver improved digital learning activities. IT constructs bound together with practices for delivering educational experiences undergo both change and replication (sharing). This IT tool and behavior bundle is akin to an extended phenotype in the ecosystem. While individual participants in the market come and go, it is this ever-evolving bundle of tool and behavior that constitutes the enduring change people seek. This sounds complex, and it is. I believe it follows from the intrinsically complex nature of teaching and learning.

The difficulty of instruction, I contend, is just beginning to be appreciated by those closest to the instructors: the staff, the administrators, and the vendor community. How complex is instruction? As it turns out, it could be wildly complex. According to Kenneth Koedinger, Julie Booth and David Klahr, a learning environment yields 205 trillion ($10^{14.3}$) options to consider in crafting an appropriate digital learning experience.[2] The authors are perhaps carefully understating the size of the problem by choosing a very small set of operational definitions of a learning environment. Expanding their model to match a more realistic depiction of a digital learning environment yields a problem space of 10^{629} combinations to address. Exploring this problem space will require many decades of research insights, data, and advances in learning theory. Researchers studying how humans learn are faced with a plethora of overlapping and often conflicting theories and approaches. A single theory of the mind useful for designing detailed digital interactions

may not be simply on a distant horizon; it may be a mirage on that horizon. In this regard, we are still very early in the study of learning.

In many ways, the health care community is ahead of the education community. The twentieth century planted the scientific method firmly into the process by which treatments are applied to patients. Peer-reviewed science and gold standards of empirical research are now standard practice before the medical community adopts changes. With the plethora of websites available, some of which provide high-quality information, many patients learn about the treatments they are going to receive and visit their doctors better informed. Many patients now understand the set of cause-and-effect relationships in treatments and the underlying human biology and physiology involved.

Over the past several years, when I give a presentation or talk I often start with four questions to the audience. The first question is: "Who can name a part of the human heart or explain roughly how the heart works?" I usually get a large show of hands and, in some cases, very accurate answers. I then ask: "Armed with this knowledge, how many of you would offer suggestions to a friend or neighbor about a heart problem he or she is experiencing?" I usually get no hands showing except those of people who would tell their friend to go see a doctor. With the third question, I pivot to learning science and ask: "Who can name one anatomical or functional part of the human brain involved with learning?" Unless there is the rare learning scientist in the room, no one answers. I probe with the final question: "How many of you have recommended to friends or family how they could improve learning for themselves or their children?" More hands go up. The typical answers I hear are common folk psychology answers. No one visits a website to learn about detailed scientific explanations for how learning occurs. Such a site does not exist due to the complexity of the learning research field.

Most vendors also struggle with insight into instructional science. If you poke beneath the punditry and the white papers the vendor community produces each year, you find little rigorous, peer-reviewed science in these solutions. While some vendors conduct usability studies internally, most vendors are not conducting rigorous research.[3] In my discussions with learning technology vendors and investors, most acknowledged that there is a significant lack of understanding of learning research. Instead, many of these edtech entrepreneurs (and animated political leaders!) are using faith-based reasoning to argue that information technology should not just lead to tremendous improvements in learning for all but also usher in a radical reshaping of colleges and universities. Due to the lack of detailed knowledge about how learning actually occurs, most of the advice for how to cure what ails us resembles that of ancient medical doctors prescribing bloodletting to cure diseases—well-intentioned but terribly uninformed.

Earlier this year, George Veletsianos and Rolin Moe called attention to this issue of insufficient evidence as part of a larger technocentric view of educational reform that may be problematic.[4] Many within the higher education vendor and reform communities are persistent in their belief that technology ought to provide compelling improvements in education just as it has in other industries. Our problem may be more fundamental and related both to the practically infinite nature of information itself and to the requisite complexity within the human brain that must absorb and utilize this information. For the foreseeable future, given the size and complexity of this research space, it is unlikely that any one person, team, or organization will discover an approach that will rapidly transform education. Making improvements in education through digital learning tools will require a community of experimentation and research and incremental discoveries and improvements over time. A modular, better-integrated, and flexible next generation digital learning environment will be needed.

Where CIOs Can Help

Every year as I interact with peers, my hope for the future grows. There are many ways we can help.

The first and perhaps easiest place for CIOs and IT leaders to start is by helping the IT organization learn more about how instruction and digital learning tools interact. We can shift investments to help bring in knowledgeable and

skilled experts and embed them within the various technology teams that design and deploy solutions. IT leaders serve as critical boundary spanners, bridging between the IT staff and fellow administrators and the myriad of instructors who teach in the different disciplines. IT leaders represent their concerns in countless meetings with vendors and others who are building this new ecosystem. Getting learning theory and instructional design experts well-placed in front of both vendors and faculty can make a difference.

CIOs should challenge themselves on how they conceptualize the current LMS. As noted in the earlier-mentioned ELI research on the NGDLE, the LMS is more of a tool to help in the *administration* of learning, not in the actual promotion of learning. As discussed here and elsewhere, the edtech ecosystem has undergone a type of Cambrian explosion to get around the real and perceived limitations of the LMS. The better we understand both the broad trends and the nuances in this realm, the more we can help guide the ecosystem's evolution.

In most institutions, IT leaders and staff serve predominantly administrative and business functions. While most have an IT leader and some staff dedicated to the teaching and learning mission, these are usually a very small fraction of the whole. Few CIOs and IT leaders have sufficient training in or experience with the teaching and learning domain. This creates a blind spot where IT units inadvertently cut off teaching and learning initiatives by treating these systems as minor appendages to the mass of information technology supporting the institution. Valuable data from administrative systems (including student administration systems) fails to cross over to the teaching and learning realm and vice versa. Many IT staff members are not knowledgeable enough, not interested enough, or not trained enough in our teaching and learning missions. To properly design and integrate the next generation learning technology ecosystem, we need more IT leaders and IT staff engaged in learning theory.

IT leaders can demand better content and data integration from their vendors. The standards market is maturing rapidly with adoption steadily growing, but more needs to be done. CIOs and IT leaders can enforce these standards during procurement processes and can help rally support from instructors and educational staff for these standards. When institutions demand standards, vendors respond. But the compliance with good standards needs to be placed before a purchase decision; it is much harder to require vendors to adhere to standards after the purchase event. Here, IT discipline matters. These standards can ease data and content integration and help create a better experience for students and instructors. Just because we go digital doesn't mean we operate in the dark. We need to make sure faculty and institutions maintain a digital "line of sight" with their students. The integration, especially the data integration, will ensure that instructors and researchers have insight into the digital learning experience.

IT leaders can shift investments to help bring in knowledgeable and skilled experts and embed them within the various technology teams that design and deploy solutions.

I also suspect that the edtech ecosystem may be dependent on these standards to ensure vibrancy. Unless there is a way to collect data for insight and to easily deploy tools, institutions may grow weary of the effort that ad hoc integration brings and may back away from supporting broader intra- and inter-institution collaboration.

IT leaders can do their part to enable sharing of data and teaching practices. This new edtech environment will need an analytic infrastructure to bring together all the data from each module in the edtech ecosystem so it can be easily analyzed, abstracted, and absorbed. Whereas all institutions are working for better collaboration across the academy, the difficult demands of each discipline often frustrate the reallocation of time for this purpose. To take advantage of these next generation learning technologies, institutions are going to need not just a community of instructors who want to advance the science and art of teaching in their own disciplines, but enough instructors who want to participate in building the human and technical systems that can share insights and teaching practices across the disciplines. CIOs can help by prioritizing IT projects than can advance both technical and human collaboration across the academy.

IT leaders need to encourage, coax, or otherwise mandate that vendors build solutions that help the community. I have talked to many vendors and several of their investors. All of them are curious and passionate about what they are doing. In some cases, however, they believe that both the data and the algorithms must be under lock and key and cannot be shared with the institution. CIOs and IT leaders can help set vendors' expectations. Higher education tends to have a culture of considerate collaboration between institutions. We regularly share our teaching methods and findings with each other in many venues, ranging from peer-reviewed journal articles to brown-bag lunch sessions. Vendors have a culture of intense competition as they seek significant, long-term profits. Many vendors place their algorithms and sometimes their data under lock and key, hoping this intellectual property will be a major source of future profits. While the complexity of instruction and the ease of reverse-engineering technical solutions make it very unlikely that any single vendor will invent such an algorithm, this culture difference

creates a problem when those of us in higher education need the ecosystem to share data, algorithms, content, and insights more broadly. Our job is to manage the differences between these two cultures and bring collaborative, not overly competitive, learning solutions to our institutions.

The edtech ecosystem brings forth its own set of privacy, ownership, and security concerns. Learning analytics can reveal a lot about both learners and instructors, so this data needs to be carefully stewarded. IT leaders can help lead in establishing new or adopting existing privacy principles, policies, and guidelines and then advocating on behalf of faculty and students when engaging with the edtech vendor community.

IT leaders can also have a voice within industry and governance groups. By having conversations with these stakeholders across different and sometimes provocative dimensions, they can continue to advocate for a collaborative community of institutions and edtech solution providers who will collectively advance the art and science of learning and learning analytics for the good of all.

CIOs can help bridge the divide between true innovation and the status quo by connecting instructors and lead designers with the product design teams within edtech companies.

In the past several years, more CIOs are getting involved in innovation. Because the IT infrastructure tools have sufficiently advanced in the past decade or so, IT leaders can devote more time to innovation, encouraging local experimentation within and between institutions. They can help share best practices, especially around learning systems infrastructure, analytics, and integration techniques. And they can promote the right balance between the diversity of instructional technologies needed and the parsimony that will be cost-effective. Of all the areas of higher education technology, the NGDLE can provide some of the more meaningful and impactful innovations.

While edtech vendors build products, more importantly they construct marketing narratives around those products. What we sometimes fail to realize in higher education is that the narrative the vendors create has to fit within the confines of the institutions they serve first. These narratives must be understandable, nonconfrontational, digestible, and consumable. Often, edtech vendors merely mirror higher education's current average practice or that of their first adopters. Far from blazing into new territory, many edtech startups walk a familiar and comfortable trail. CIOs can help bridge the divide between true innovation and the status quo by connecting instructors and lead designers with the product design teams within these edtech companies.

Dare to Join the Revolution?

As colleges and universities continue to bring on additional technologies, including mobile and real-time learning analytics tools, those of us in higher education are going to be challenged to make dreams come true in ways we have not seen before. While many external stakeholders in government and industry are waiting for technical innovation to transform teaching and learning by itself, sans humans, that is like waiting for Godot. For the foreseeable future, tackling the enormous complexity in the art and science of learning will take a village. A really big village. We will need higher levels of human and technical integration. CIOs and IT leaders are well positioned to help.

These innovations in next generation digital learning environments—in the edtech ecosystem—are coming. What we collectively do next will determine the outcome. ■

Notes

1. Malcolm Brown, Joanne Dehoney, and Nancy Millichap, *The Next Generation Digital Learning Environment: A Report on Research*, an EDUCAUSE Learning Initiative (ELI) white paper (April 2015).
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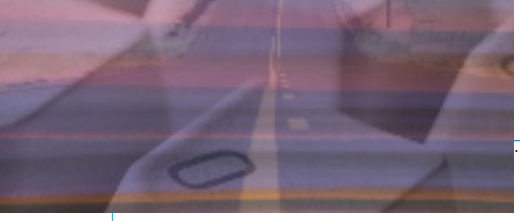

Acceleration: A Degree-Completion Strategy for Online Adult Students

According to the American Association of Community Colleges, adult students accounted for 63 percent of community college enrollments in 2016.[1] Because adult students commonly juggle college against work and family obligations, community colleges strive to develop alternative strategies and technologies to meet their needs. One of the most universally employed technologies for adult student education is online learning.

The National Adult Learner Coalition writes: "Online education has massively expanded access for adult learners, transcending not only distance but time, since many of these adults require the flexibility of schedule that online programs offer."[2] In Florida, for example, the state legislature has funded Complete Florida, an online initiative for Florida's 2.1 million working-age adults who have some college credits but stopped short of a baccalaureate-level credential.

In spite of the growth of online education, degree completion continues to challenge adult students. Nationally, the six-year completion rate for adults is 21 percent lower than for traditional-age students.[3] Jobs for the Future identifies acceleration as a degree-completion strategy that is essential for adult student success. Students who choose an accelerated program earn as many credit hours to complete a degree but move at a faster rate, which is important.[4] A national study conducted by Complete College America indicates that the longer it takes an adult to complete college, the less likely it is the adult will finish.[5] In other words, the longer adults are in college, the more likely it is that life will get in the way.

Below are four common acceleration strategies used in many community colleges today: multiple start/accelerated terms; competency-based education (CBE); Alternative Credit Project (ACP); and prior learning assessment (PLA).

- *Multiple Start/Accelerated Terms.* This option refers to courses offered in 5-, 6-, 8-, and 12-week terms. These options in scheduling are designed to give students the ability to take multiple courses, one at a time and sequentially. Students do not have to wait for the start of a new semester to take a class.
- *Competency-Based Education (CBE).* CBE permits students to progress through coursework at their own pace and receive credit based on their demonstrated mastery of competencies through tests, projects, and portfolios. CBE programs typically start new classes weekly, monthly, or even "on demand"—meaning anytime the student is ready.
- *Alternative Credit Project (ACP).* Through ACP, students are provided a pool of online courses that an institution will accept toward their degree. The courses offered are at little to no cost across more than twenty subject areas from multiple providers.
- *Prior Learning Assessment (PLA).* PLA allows students to demonstrate what they know to earn course credit, either through examination or through the development of a portfolio of work. By demonstrating mastery of course content and objectives in this way, students can bypass coursework and progress more quickly toward a degree.

Technology Demands of Acceleration

Most acceleration strategies imply fully online, asynchronous, individualized, self-paced instruction that requires delivery through a robust learning management system (LMS) that can

- release content and course materials to each student in small, flexible chunks (i.e., modules) just at the time he or she needs them;
- track students who are moving at different paces and provide real-time progress and performance data to faculty members, coaches, and administrators;
- post and accept assignments and assessments at different times for different students;
- accommodate "rolling enrollments" that allow a student to complete and exit a course at some random, interim point in a semester and then enroll immediately into a subsequent course; and
- provide courseware-development and management capabilities that enable instructors to create, access, and curate materials and even open textbooks to ensure variations in student learning styles and aptitudes are accommodated.

While no single platform solution has yet been developed to support all of these requirements, many companies are working on them. LMS providers continue to add functionality that enables flexibility in course delivery and assessment, multilayer communication and interaction, and deep analytics around student behaviors and performance in online courses. Most LMS providers have at least developed prototype versions of platforms to support personalized, adaptive, and competency-based learning approaches:

- Cengage Learning recently released Learning Objects, its competency-based learning platform that supports self-

Connections Editor: **Bret Ingerman**

By ROBIN COLSON

paced, mastery-driven instruction that maps learning goals to assessments and learning activities.
- LoudCloud, in partnership with Barnes & Noble Education, has released its own adaptive platform specifically tailored to support competency-based learning.
- Motivis Learning is a platform built on Salesforce, a commercial customer relationship management tool. Motivis bills itself as a learning relationship management platform that "unifies content, communication, and data."
- Canvas by Instructure touts its open-source software and its extensive, open API that allows third-party apps to interface with Canvas to share data and integrate new technologies into courses.
- Brightspace by D2L bills itself as easy, flexible, and smart—able to deliver personalized or competency-based instruction to anyone, anyplace.

Acceleration in Florida

Complete Florida is a network of fourteen regionally accredited partner institutions that have committed to provide online courses and programs and other technology-supported strategies that have been shown to meet the unique needs of adult students. Below are acceleration strategies being used (or tested) by four Complete Florida partner schools:

- *Florida State College at Jacksonville.* FSCJ Online offers students a variety of accelerated degree options in fields such as Business and Management, Health and Human Services, Information Technology, Education, Logistics, and an online Associate in Arts degree. There are three acceleration options at FSCJ: courses offered in compressed timeframes such as 8-week courses; credit offered through direct examination, which allows students to obtain credit for over 70 courses by passing an exam; and credit offered through PLA. Using PLA, students may receive credit by providing documentation of nonaccredited training such as military or corporate training. A one-hour online portfolio-development course teaches students how to document their learning via a portfolio so they may receive course credit.
- *Indian River State College.* In response to increasing demands for flexible, web-based course delivery, IRSC created its Virtual Campus and now offers 12 totally web-based degrees and hundreds of individual web-based courses. These programs enable a year-round registration schedule to provide students with multiple start options and the ability to move on more quickly to new courses without waiting for the start of a traditional semester. The Virtual Campus offers courses and degrees designed using the Quality Matters (QM) instructional design rubric. Instructional designers work collaboratively with faculty members to design the online courses, ensuring that the courses contain online pedagogy based on instructional design theory. IRSC has 176 QM-certified faculty members and over 250 courses that have achieved QM certification.
- *Miami Dade College.* MDC is a participant in the ACP, a program designed to help adults finish a degree or postsecondary certificate by offering them low-cost, online courses *prior to* admission. The concept is that many adult students have skills and knowledge that will enable them to complete these classes quickly and kickstart their program at MDC. The college will accept up to 45 ACP credits toward a degree. MDC faculty have reviewed and identified the courses they will accept into programs of study so students can clearly see the path forward.
- *Polk State College.* Polk State College has created an engineering technology CBE program that allows students to take classes at their own pace, often accelerating and earning their degrees quickly, based on the student's ability to demonstrate mastery of required modules. CBE students are also able to register for and begin courses any day of the year that the college is open for business. This means that once students successfully finish a course, even if in mid-semester, they can begin the next course immediately, which eliminates the delay of waiting for the start of a new semester and significantly reduces overall degree-completion time. A recent student, for example, completed his associate in science degree in just 16 months.[6]

As online programs continue to be an increasingly popular means of improving adult students' access to a college education, online student success strategies such as acceleration—and the technologies required to support them—will continue to be a significant area of focus for higher education institutions, particularly those serving primarily adult students. ■

Additional contributions to this article were provided by Peter Shapiro, Florida State College at Jacksonville; Naomi Boyer, Polk State College; and Kendall St. Hillaire, Indian River State College.

Notes

1. American Association of Community Colleges, *2016 Fact Sheet*.
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Globalization, Open Access, and the Democratization of Knowledge

In many ways, developments in information and communication technology (ICT) and open access have disrupted inequities in academic publishing and global information flows. However, efforts to fully globalize and democratize information demand intentional efforts to involve and center perspectives that traditional forms of communication have marginalized. Information professionals and the systems they create must proactively attend to developing equitable and inclusive information systems. Initiatives such as SHARE and FORCE11, discussed below, indicate promise for fulfilling the vision and promise of democratized knowledge.

Each advancement in ICT, from codex to microfilm, has increased our ability to transmit knowledge across space and time. The evolution of ICT and the internet in particular has vastly increased the distance and speed at which information can travel. As Casey Coleman, former CIO of the U.S. General Services Administration, asserts: "Technology has a 'democratizing' effect, eliminating barriers and granting access so that new ideas can spread."[1] Through the internet, the public has the ability to participate in the global accumulation of knowledge, by creating websites and blogs and by contributing to crowdsourced sites like Wikipedia and the Internet Movie Database (IMDb).

The open-access movement, as articulated in the 2002 Budapest Open Access Initiative declaration, is characterized by lofty ideals that seek to enact this democratizing effect in the scholarly realm. The declaration states: "Removing access barriers to this literature will accelerate research, enrich education, share the learning of the rich with the poor and the poor with the rich, make this literature as useful as it can be, and lay the foundation for uniting humanity in a common intellectual conversation and quest for knowledge."[2] In subverting the now typical commodification of knowledge and information, open access is posited as a way to bring equity to information consumption and to advance knowledge and development.

In traditional publishing, information inequities are created in a process that some have termed *the colonization of information*. The flow of information from the Global South[3] to the North is characterized as a mining of information, knowledge, data, and heritage to support research conducted in the North. The resulting scholarship then circulates among scholars in the North, with researchers located in the Global South encountering significant barriers to gaining access to and contributing to this circulation of knowledge. As Johannes Britz and Peter Lor note: "From an African perspective a problem arises when this flow [of information] is one-way, i.e. when the researchers subsequently fail to provide the host country with copies of dissertations and research publications arising from their work in that country."[4] With the exponential rise of subscription costs for journals published in the North, researchers with neither access to well-resourced libraries nor the means to purchase individual subscriptions have been denied access to the scholarly record.

In recent decades, the internet has created new channels to facilitate the global spread of knowledge. The development of institutional repositories through which scholars self-archive an open copy of their publications and the growth of open-access journals more broadly together are freeing information that would otherwise have been trapped behind subscription paywalls. For researchers in the Global South, access to cutting-edge research no longer has to be cost-prohibitive. For scholars in the North, this presents new opportunities to repatriate knowledge, providing communities with scholarship arising from research conducted in those communities.[5] The benefits of this repatriation can range from shaping policymaking to improving local practices.

These developments also provide scholars who have been marginalized in traditional academic publishing, including scholars from the Global South, an opportunity to contribute to the scholarly record. Through open-access initiatives, researchers have opportunities to increase access to their work even if they are not able to publish in top-tier journals with high circulation rates. The addition of Southern perspectives can help to reframe methodologies and frameworks used in the North, especially in researching global issues. In the context of climate change research, for example, Malgorzata Blicharska and her coauthors posit that knowledge featuring contributions from both the North and the South "will be seen as more impartial (not biased by a Northern-dominated perspective) and relevant (sensitive to local contexts in both Northern and southern countries)."[6]

By promoting interoperability and implementing common standards, we are beginning to see national and regional efforts to aggregate openly accessible content from institutional repositories and funding agency repositories, making the body of self-archived literature easier to discover. SHARE embodies this effort in the United States. As regional networks mature, interoperability and harvesting will allow research from one region to be discoverable in another. OpenAIRE, the European repository network, is harvesting records from LA Referencia,

E-Content Editor: **Lisa Janicke Hinchliffe**

the Latin American network, after LA Referencia adopted OpenAIRE guidelines for standardized metadata elements and vocabularies. These network linkages reduce geographic barriers to accessing international scholarship. On a smaller scale, libraries should include international open-access networks as targets in their discovery systems.

While we have witnessed an increase in the amount of scholarship openly accessible to the public, developments in ICT and scholarly communication are not a panacea for all barriers to knowledge access and production. True democratization and globalization of knowledge cannot exist without a critical examination of the systems that contribute to the production of scholarship.

The concept of the digital divide describes the lack of technological infrastructure available in the Global South, placing the South at a disadvantage in a global economy that has commodified information. Open-source software is touted as a low-cost method of bringing ICT to the Global South. When developing open-source software to manage and publish scholarship, partners from the Global South must be engaged from the onset so that their needs and perspectives can be included in the earliest stages of development. We cannot assume that tools developed to meet the needs of North American and European scholars will be of equal utility for those in the Global South.

Language is another barrier that may be mitigated through technology. With English as the *lingua franca* of research, the scholarly record is largely inaccessible to the non-Anglophone world. To increase the international utility of networks, repository and publishing platforms should have embedded translation tools. If it is not feasible to translate the full-text of the scholarship, we should aim to build systems that can, at the least, translate the metadata describing the knowledge contained in the systems, allowing researchers to determine whether pursuing their own translation is worth the expense and effort.

Academic publishing also presents systemic barriers and biases that ICT cannot solve. In discussing archival digitization projects in South Africa, Michele Pickover writes: "Many of these projects are fundamentally located in uneven power relations and perspectives which compromise national heritage; do not represent the views and interests of the developing nations; bolster inequities in globalisation; and exacerbate historic North/South imbalances. Increasingly . . . the real challenges are not technological or technical but social and political."[7] The Andrew W. Mellon Foundation funded two phases of Digital Innovation South Africa (DISA), a digital archive providing online access to records documenting liberation struggles in South Africa. During the second phase of funding, the Mellon Foundation developed its own digital archive, Aluka, providing access to the documentation of liberation struggles across Africa. But Pickover notes that rather than recognizing and prioritizing the needs of the project's South African partners, Aluka influenced content selection for DISA. Likewise, in academic publishing, a Northern perspective dominates the selection of content for inclusion in the scholarly record, driven by editorial boards composed of researchers in Europe and North America.

Economically disenfranchised populations continue to be denied access to knowledge in a scholarly communication ecosystem reliant on resource-intensive ICT. Open access means little to communities without a stable telecommunications infrastructure. Open-access scholarship is simply not possible in places that lack reliable electricity and networks. Projects such as WiderNet's eGranary Digital Library aim to bridge this divide by making digital resources available offline on hard drives. As an offline resource, however, eGranary presents a snapshot of the world frozen in time, containing primarily English-language content selected in the United States. Bonny Norton and Carrie-Jane Williams note that the use of eGranary with students in Uganda relied on solar power, in a village that lacked electricity and running water.[8]

As we develop the next iterations of ICT for scholarly communication, voices from the Global South must be present from the onset. The FORCE11 Scholarly Commons Working Group has been established to create a set of principles that can guide the development of a scholarly communication working ecosystem. After the group's last workshop, a Self Critique subgroup was formed in response to criticisms that the working group was dominated by Northern perspectives. This self-reflective effort should be adopted by all scholarly communication initiatives. As we advance the principles of open access, we must critically examine our work to ensure that our efforts are moving us to a true democratization of knowledge, working toward equity in accessing and contributing to the global scholarly record. ■

Notes

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2. "Read the Budapest Open Access Initiative," February 14, 2002, Budapest Open Access Initiative website.
3. In this article, I use the phrase *Global South* in lieu of value-laden descriptors such as *Third World* or *developing countries*.
4. Johannes J. Britz and Peter J. Lor, "A Moral Reflection on the Information Flow from South to North: An African Perspective," *Libri* 53 (2003), 168.
5. In using the phrase "to repatriate knowledge," I am excluding the digital repatriation of culturally sensitive indigenous knowledge and artifacts, the politics of which are outside the scope of this article.
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Pedagogy and the Logic of Platforms

In 1974, computers were oppressive devices in far-off air-conditioned places. Now you can be oppressed by computers in your own living room.
—Theodor Holm "Ted" Nelson,
Computer Lib: Dream Machines (1987)

In his initial New Horizons column in *EDUCAUSE Review*, Mike Caulfield asked: "Can Higher Education Save the Web?"[1] I was intrigued by this question since I often say to my students that the web is broken and that the ideal thing to do (although quite unrealistic) would be to tear it down and start from scratch.

I call the web "broken" because its primary architecture is based on what Harvard Business School Professor Shoshana Zuboff calls "surveillance capitalism," a "form of information capitalism [that] aims to predict and modify human behavior as a means to produce revenue and market control."[2] Web2.0—the web of platforms, personalization, clickbait, and filter bubbles—is the only web most students know. That web exists by extracting individuals' data through persistent surveillance, data mining, tracking, and browser fingerprinting[3] and then seeking new and "innovative" ways to monetize that data. As platforms and advertisers seek to perfect these strategies, colleges and universities rush to mimic those strategies in order to improve retention.[4]

Students are often surprised (and even angered) to learn the degree to which they are digitally redlined, surveilled, and profiled on the web.

That said, I admit it might be useful to search for a more suitable term than "broken." The web is not broken in this regard: a web based on surveillance, personalization, and monetization works perfectly well for particular constituencies, but it doesn't work quite as well for persons of color, lower-income students, and people who have been walled off from information or opportunities because of the ways they are categorized according to opaque algorithms.

My students and I frame the realities of the current web in the context of digital redlining, which provides the basis for understanding how and why the web works the way it does and for whom. The concept of digital redlining springs from an understanding of the historical policy of redlining: "The practice of denying or limiting financial services to certain neighborhoods based on racial or ethnic composition without regard to the residents' qualifications or creditworthiness. The term 'redlining' refers to the practice of using a red line on a map to delineate the area where financial institutions would not invest."[5]

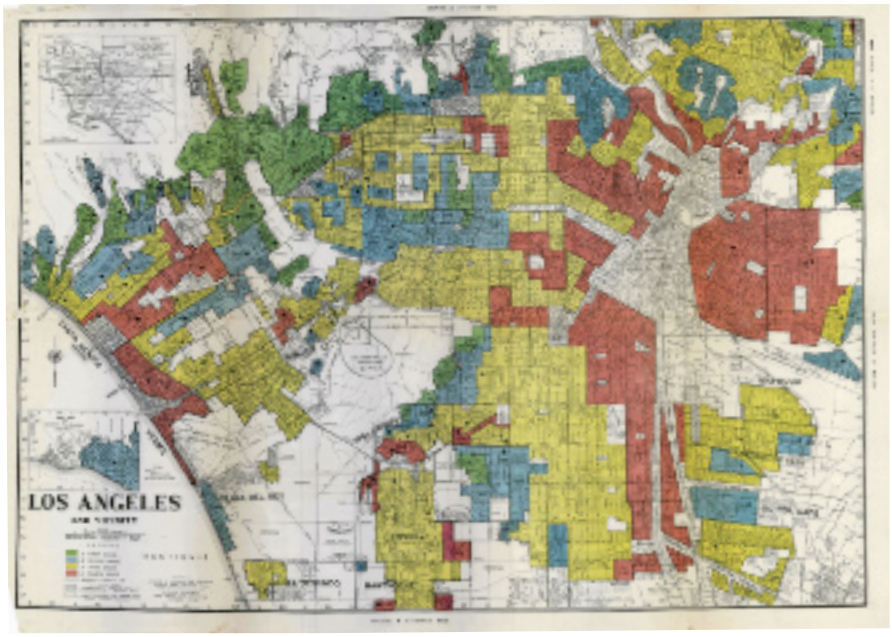
In the United States, redlining began informally but was institutionalized in the National Housing Act of 1934. At the behest of the Federal Home Loan Bank Board, the Home Owners Loan Corporation (HOLC) created maps for America's largest cities and color-coded the areas where loans would be differentially available. The difference among these areas was race.

Digital redlining is the modern equivalent of this historical form of societal division; it is the creation and maintenance of technological policies, practices, pedagogy, and investment decisions that enforce class boundaries and discriminate against specific groups. The *digital divide* is a noun; it is the consequence of many forces. In contrast, *digital redlining* is a verb, the "doing" of difference, a "doing" whose consequences reinforce existing class structures. In one era, redlining created differences in physical access to schools, libraries, and home ownership. In my classes, we work to recognize how digital redlining is integrated into technologies, and especially education technologies, and is producing similar kinds of discriminatory results.

We might think about digital redlining as the process by which different schools get differential journal access. If one of the problems of the web as we know it now is access to quality information, digital redlining is the process by which so much of that quality information is locked by paywalls that prevent students (and learners of all kinds) from accessing that information. We might think about digital redlining as the level of surveillance (in the form of analytics that predict grades or programs that suggest majors to students). We also might think about digital redlining to the degree that students who perform Google searches get certain information based on the type of machine they are using or get served ads for high-interest loans based on their digital profile (a practice Google now bans). It's essential to note that the personalized nature of the web often dictates what kind of information students get both inside and outside the classroom. A Data & Society Research Institute study makes this clear: "In an age of smartphones and social media, young people don't follow the news as much as it follows them. News consumption is often a byproduct of spending time on social media platforms. When it comes to getting news content, Facebook, Twitter, Instagram and native apps like the Apple news app are currently

New Horizons Editor: **Michael Caulfield**

By CHRIS GILLIARD



Courtesy Mapping Inequality © 2017

the most common places where the teens and young adults in our focus groups encounter news."[6]

Students are often surprised (and even angered) to learn the degree to which they are digitally redlined, surveilled, and profiled on the web and to find out that educational systems are looking to replicate many of those worst practices in the name of "efficiency," "engagement," or "improved outcomes." Students don't know any other web—or, for that matter, have any notion of a web that would be different from the one we have now. Many teachers have at least heard about a web that didn't spy on users, a web that was (theoretically at least) about connecting not through platforms but through interfaces where individuals had a significant amount of choice in saying how the web looked and what was shared. A big part of the teaching that I do is to tell students: "It's not supposed to be like this" or "It doesn't have to be like this." The web is fraught with recommender engines and analytics. Colleges and universities buy information on prospective students, and institutions profile students through social media accounts.[7] Prospective employers do the same. When students find out about microtargeting, social media "filter bubbles," surveillance capitalism, facial recognition, and black-box algorithms making decisions about their future—and learn that because so much targeting is based on economics and race, it will disproportionately affect them—their concept of what the web is changes.

Another aspect of my teaching is rethinking the notion of "consent." It's important to ask: What would the web look like if surveillance capitalism, information asymmetry, and digital redlining were not at the root of most of what students do online? We don't know the answer. But if higher education is to "save the web," we need to let students envision that something else is possible, and we need to enact those practices in classrooms. To do that, we need to understand "consent" to mean more than "click here if you agree to these terms."

I often wonder if it's possible to have this discussion without engaging in a deep and ahistorical practice of nostalgia. Telling students about the "good old days" of hand coding and dial-up internet access probably isn't the best way to spend classroom time. However, when we use the web now, when we use it with students, and when we ask students to engage online, we must always ask: What are we signing them up for? (Ultimately, we must get them to ask that question themselves and take it with them.) Here the term "consent," often overused and misunderstood, needs to be foregrounded in the idea that we must do all we can to explore the reality that students are entering into an asymmetrical relationship with platforms.

While we can do our best to inform students, the black box nature of the web means that we can never definitively say to them: "This is what you are going to be a part of." The fact that the web functions the way it does is illustrative of the tremendously powerful economic forces that structure it. Technology platforms (e.g., Facebook and Twitter) and education technologies (e.g., the learning management system) exist to capture and monetize data. Using higher education to "save the web" means leveraging the classroom to make visible the effects of surveillance capitalism. It means more clearly defining and empowering the notion of consent. Most of all, it means envisioning, with students, new ways to exist online. ■

Notes

1. Michael Caulfield, "Can Higher Education Save the Web?" *EDUCAUSE Review* 52, no. 1 (January/February 2017).
2. Shoshana Zuboff, "Big Other: Surveillance Capitalism and the Prospects of an Information Civilization," *Journal of Information Technology* 30, no. 1 (March 2015), 75.
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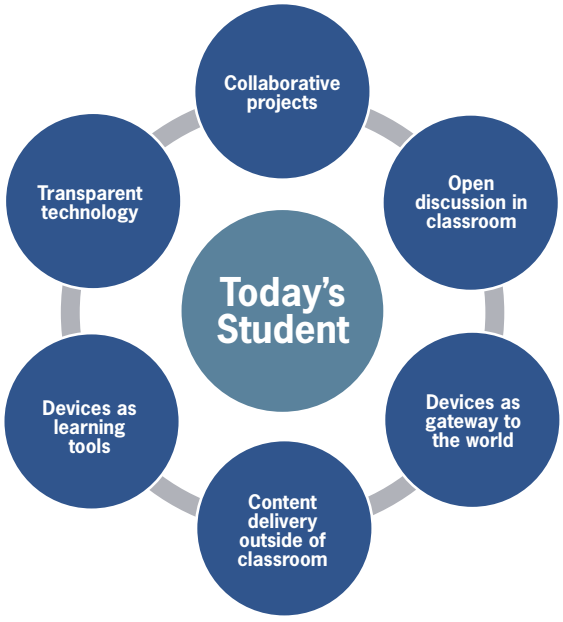
Next Generation Classroom—Some Random Thoughts

When you think of a next generation classroom, what comes to mind? Is it a classroom visibly filled with the newest, flashiest technology?

Not for me. In my ideal next generation classroom, technology is transparent, and the focus is on people. Whatever technology is in my next generation classroom exists only to support human connection and the sharing of ideas. It nurtures academic goals; nothing is installed for technology's sake. Technology is a component of my ideal classroom, but only if it is used appropriately. In this classroom, technology enables the aspects needed to enhance the learning experience for today's student (see figure 1).

Figure 1. Today's Student



Transparency can be interpreted two different ways, and the technology of the next generation classroom should fit both. First, it should be invisible. For technology to become invisible to faculty and students, it must be easy to use. Instructors often struggle with projectors, lights, and media panels. I have been challenging my staff to create a classroom that automatically configures itself for an instructor when he or she simply walks into the room: displaying the course name on the projector, dimming the lights when a computer is connected, and offering easier methods of projecting (e.g., a one-button USB dongle). In a data-driven college or university, we know the class schedule and can remember instructors' preferences, making personalization feasible.

Invisible technology also shouldn't create barriers between people. We must not spend class time with faces shielded by laptop screens. Instead, we should be free to interact, invisibly aided by technology. Technology shouldn't distract students from the subject or the people around them. Instructors often avoid using engaging tools like online polling because they fear students will quickly be distracted by social media when they take out a laptop, phone, or tablet. But if a student's device is his or her way to stay connected to the world, why should we take it away in a class? Can't we work *with* these powerful tools instead of around them? For example, I like to ask my students to look up concepts online during class to encourage the productive use of devices.

Distraction is not my greatest problem with these devices. My concern is that if students do not have additional tools, the information they find on their devices is visible only to them, instead of being shared with the rest of the class. Speaking to the second meaning of *transparency,* I want the information in a classroom, whether it is the instructor's slides or the students' insights, to be available to all. Technologies that use natural language processing (NLP) such as Google Home can be a powerful classroom asset, allowing an entire class to receive the information together.

My ideal next generation classroom adopts a blended model, using both online content and classroom sessions. I've taught with a flipped classroom model for years. I use Panopto Recorder on my computer to record a week's worth of information, including both my webcam video and the slides. I love the flipped classroom model because it frees me from the pressure of covering an entire week of material in one session.

Some instructors have difficulty negotiating the balance between online delivery methods and live classroom sessions. When my colleagues ask for advice, I point out that the successful 21st-century course is not about classroom versus online; rather, it's always about pedagogy and content delivery. When they are designing courses, faculty should ask: "If my students are coming to class in this globally connected world, why would they want to come to a *classroom*?"

In a blended model, the heavy information transfer occurs outside the classroom, so when we're in the classroom the focus is on people. Decades ago, information was more difficult to find, and live instruction was the most valuable way to transmit information to students. Today, students not only consume information provided by instructors outside of class time but also seek ideas from multiple sources and connect it to what they learn in class. Through the power of the internet, content and knowledge have been liberated. Because of this, an instructor's time is better used to create a sounding board for students, helping them

Viewpoints Editor: **Klara Jelinkova**

By RAVI PENDSE

increase the strength and the quality of their thinking. This is also a better use of students' time, and students notice and appreciate when instructors respect and value their time. When a class is able to have free-flowing conversations, students learn something more important than the information: they learn how to think. Through spontaneous classroom discussion, students are able to connect learning concepts with relevant and interesting thoughts, from news articles to fiction. Creating connections and synthesizing information are key to learning.

The success of a flipped classroom is not just about the quality of the technology; it's also about the agreement that instructors have with their students. If several students don't view the content before class, they will not get as much out of the in-person session and will hold back their classmates. During the first few classes of some semesters, I get a blank look from those students who have not watched my recordings. I have some tricks to reduce the number of these blank looks. During a recent semester, I subtly told my students that I could tell which of them had watched my online content. I also regularly give quizzes on the material. However, it's important that these measures do not feel punitive and that I am creating an atmosphere of learning and mutual trust. Some days students may be unprepared, but instructors can accept that and use it as an opportunity for conversation.

A blended classroom has other benefits. I have challenged my faculty colleagues to "weatherproof" their classes, allowing students to join them during inclement weather thanks to easy tools like Cisco WebEx. I also use this technology to teach when I'm traveling. In addition, the rich, searchable content available through a lecture-capture tool like Panopto is valuable for different styles and abilities of learners. Technologies that increase the accessibility of content benefit all. For example, after we added captioning to many of our lecture-capture courses, I heard from students who do not necessarily have a disability but who rely on the captions when they are studying in quiet libraries. We originally purchased Dragon speech-recognition software for students with disabilities, but it also proved useful for PhD students working on their dissertations. Typing hundreds of pages can be time-consuming and uncomfortable; the dictation software makes the task easier, especially for slower typists and those with less-than-ergonomic home offices.

The next generation learning experience should lean heavily on collaboration. I see a trend, especially in the sciences, that worries me. Many instructors discourage or even forbid students from collaborating with their classmates, considering it to be cheating. This puts enormous pressure on students. More importantly, this type of learning does not model what they will encounter in the work world, where they will be not discouraged but, rather, *expected* to collaborate. While I understand the necessity for independent work, there are other ways to achieve the goal of mastery while encouraging collaboration. Some instructors simply alternate assignments, requiring independent work with collaborative projects. Collaborative work can also be paired with lessons about ethics and plagiarism to help shape our students into responsible, ethical adults.

Some of my contemporaries seem pessimistic about today's students, noticing, for example, that students prefer smartphones to books. I don't subscribe to this pessimistic view. The same tension occurs with every generation: I remember this skepticism from older generations when I was young. Today's students grew up with information at their fingertips, so they think differently and learn differently. We should recognize that what they need from a next generation classroom is different too. ■

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Relevance of the NGDLE to Community and Technical Colleges

The Kentucky Community & Technical College System offers a good example of the importance of a next generation digital learning environment having the diverse features required to meet the needs of students across KCTCS's 16 accredited community and technical colleges.

Accessibility as a Vital Contributor to the NGDLE's Success

The five tenets of the next generation digital learning environment help explain not only its powerful promise but also its present day reality: interoperability, personalization, analytics, collaboration, and accessibility. Accessibility in particular plays a vital role in usability.

A Holistic Approach to Planning for the Next Generation of Services Using Enterprise Architecture Practices

Higher education institutions should take a holistic view of next generation digital learning environments and next generation enterprise IT platforms; they have much in common, and thoughtful attention to IT enterprise architecture holds the key to successful implementations.

Upcoming issues will focus on artificial intelligence and virtual reality; diversity, equity, and inclusion; and community college perspectives.

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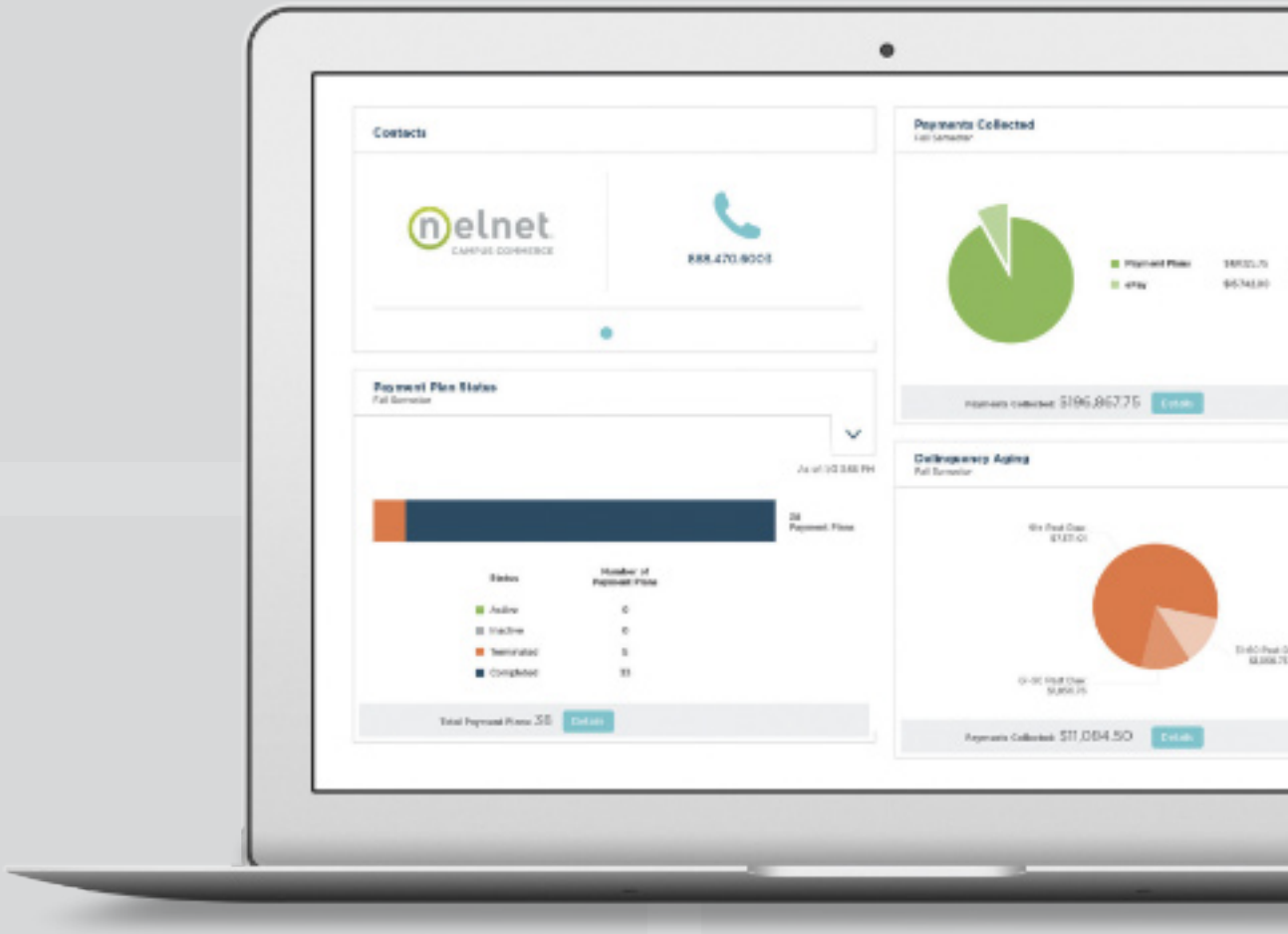

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