Introduction

Since 2014, EDUCAUSE has examined higher education’s top strategic technology priorities. This year, in addition to reviewing the overall list of strategic technologies, EDUCAUSE will publish nine separate reports examining in detail the technology domains we asked about and reviewing each domain’s component technologies and the trends associated with those technologies. This report covers the 29 technologies and 10 trends included in the teaching and learning domain.

EDUCAUSE assesses strategic technologies annually. This year we began publishing a series of strategic technology reports focused on specific domain areas to provide a consolidated view to readers interested in particular areas. This report centers on technologies supporting higher education’s primary mission, teaching and learning. As educational technologists know well, teaching and learning is a complex domain, a kind of ecosystem with many technology “organisms” in collective motion. The EDUCAUSE strategic technology teaching and learning domain contains more technologies than any of our eight other domain reports. The length of the list and the diversity of its technologies pose a challenge: How can we connect these technologies in a way that provides a coherent and enabling pedagogical landscape for our learners and instructors? How can we, for example, share learning data across all applications so that we might have more accurate information about learner progress? It is no surprise that in articles and blog posts we are seeing increasing use of terms such as digital learning “environment” or “ecosystem.” What these descriptors suggest is that we can’t view these technologies as just a collection of applications but instead need to find ways to interconnect them using APIs and open standards in order to create the experience of a cohesive environment for learners and instructors.

Another trend that is documented in this report is the rapidly growing emphasis on student success in all its forms. In addition to technologies that support student coursework, there is now the dimension of student success in areas such as mapping out degree careers, educational planning, and degree auditing. This also includes technologies that will first assist the institution in identifying when learners are in need of interventions and then enable the institution to carry them out. These more recent dimensions of student success further illustrate both the diversity of educational technology as well as the need to weave those technologies into a connected digital learning environment.

The focus of this report is the trends and strategic technologies associated with teaching and learning. Mature, commonly deployed technologies (such as
financial information systems or networks) may be among the most mission-critical technologies, but they are generally more likely to receive operational than strategic attention. Strategic technologies, by contrast, are the relatively new technologies institutions will be spending the most time implementing, planning for, and tracking in 2017. None of the 29 teaching and learning technologies analyzed in this research is currently in place in more than 30% of institutions.

Technologies are what IT organizations do. Trends, on the other hand, are widespread external factors that influence institutional and IT strategy and often spur the adoption of technologies. This report examines the trends that institutions are paying the most attention to and that are influencing emerging institutional IT strategy the most. This year’s trend list included 10 items closely associated with teaching and learning.
Covered in This Report

Trends

- Adaptive learning
- Blending of roles and blurring of boundaries between IT and academic/administrative areas
- Changing faculty roles (focus on advising and student success, growth in adjuncts, etc.)
- Changing vendor-institution relationships (bypassing IT to work directly with business-area leaders)
- Cross-institutional partnerships and consortia
- Digitization of scholarly and research data (data management, visualization, discipline-specific tools, etc.)
- Diversity and inclusivity
- Evaluation of technology-based instructional innovations
- Institutional international strategies (international campuses and partnerships, internationalization of student body, etc.)
- IT as an agent of institutional transformation and innovation

Technologies

- Active learning classrooms*
- Adaptive learning
- Affective computing
- Augmented reality
- Blockchain
- Courseware
- Digital microcredentials
- Games and gamification
- Incorporation of mobile devices in teaching and learning*
- Institutional support for speech recognition
- Integration/uses of machine speech recognition
- iPASS (Integrated Planning and Advising for Student Success) technologies
- IT accessibility assessment tools
- Mobile app development
- Next-generation LMS
- Open educational resources
- Predictive analytics for learning
- Predictive learning analytics (course level)
- Remote proctoring services
- Technologies for degree auditing (documenting and tracking students’ educational plans)
- Technologies for improving the analysis of student data*
- Technologies for integrating student records data across case management systems
- Technologies for offering self-service resources that reduce advisor workloads*
- Technologies for planning and mapping students’ educational plans*
- Technologies for triggering interventions based on student behavior or faculty input*
- Text/content analytics
- Uses of APIs*
- Uses of the IoT for teaching and learning
- Virtual reality

*Part of the overall 2017 Top 10 Strategic Technologies
Findings and Recommendations

What do we know about the kind of progress higher education might make with teaching and learning technologies? What trends might influence this progress? While our data can never be a substitute for an institution’s own teaching and learning strategic plan or roadmap, this report can inform an institution’s overall IT strategy and academic technology-deployment strategy.

The Trends

We characterized a trend as “influential” if it was already incorporated into IT strategy or exerting a major influence over emerging IT strategy. We used that characterization to classify the trends into four levels of influence, based on the prevalence of influence across institutions:

- **Most influential**: Trends that are influential in 61% or more of institutions
- **Taking hold**: Influential in 41–60% of institutions
- **Worth understanding**: Influential in 21–40% of institutions
- **Limited impact**: Influential in 20% or less of institutions

Understand how the most influential trends are affecting your institution.

None of the trends is exerting a major influence on institutional IT strategy at 61% or more of colleges and universities.

Review the trends that are taking hold and address them at your institution.

Two trends (listed below from highest to lowest level of influence) are exerting a major influence on institutional IT strategy at 41–60% of institutions:

- **IT as an agent of institutional transformation and innovation.** Almost all projects involving strategic innovation and transformation involve IT. IT has always had a dual role with respect to transformation and innovation: IT can be the vehicle by which an innovation is realized, and new breakthroughs in IT can open the door for a new set of innovations and opportunities that were scarcely imaginable before. There is no indication that IT will relinquish this dual role; indeed, if anything, the pace of such change only seems to be accelerating. Finally, the power of IT can enable current initiatives to greatly increase their scope and scale (e.g., the collection and analysis of greater amounts of data provide the basis for new directions for business modeling and technology-enabled student advising).
- Diversity and inclusivity. Diversity and inclusivity are the lifeblood of higher education. Science and scholarship can only proceed on the basis of encouraging a diversity of opinions and insights proffered by myriad sources. Technology is a key enabler of this dimension, making it possible to draw on diverse information resources and allowing all voices to be heard. In the domain of teaching and learning, the issue of accessibility—one dimension of diversity/inclusivity—jumped from 7th to 4th in the ELI key issues survey. Both the Department of Justice and the Department of Education have become increasingly active in this area as well. For the IT organization, diversity/inclusivity issues are highly relevant to the issue of sustainable staffing as well as to IT workforce issues.

Understand these trends, and consider their possible role at your institution.

The influence of six trends is limited to 21–40% of institutions. Higher education is monitoring these trends (listed below from highest to lowest level of influence) with respect to emerging IT strategy and the deployment of teaching and learning strategic technologies:

- Blending of roles and blurring of boundaries between IT and academic/administrative areas. This trend is in evidence across all dimensions that involve the application of IT. Discussions around the issue of next-generation enterprise IT have suggested new, more integrative roles and skills for the CIO and the IT organization, such as the ability to network “throughout the institution and the higher education ecosystem” and to “integrate a myriad of ‘micro best-of-breed’ solutions...in very tailored ways.” In parallel to this, on the teaching and learning side, almost all strategic discussions around academic transformation take as a starting point the need to integrate a variety of campus organizations to further the teaching and learning mission. Entailed in this blending and blurring of roles are new job titles, new governance models, new skill sets, and new demands for professional development.

- Evaluation of technology-based instructional innovations. Evaluating the impact of technology-based innovations in teaching and learning has long been a key issue. In light of increasing demands for technology and support, often dogged by dwindling resources, the need to know which innovations have the greatest positive impact is more acute than ever. ECAR research on faculty and IT shows that the greatest motivator for faculty to incorporate technology into their teaching is evidence of its benefit to students. Due to the complexity of measuring pedagogical impact, a variety of evaluation methods must be utilized to produce the evidence persuasive to key stakeholders.
- Cross-institutional partnerships and consortia. In an effort to be as efficient as possible with enterprise IT systems and services, many institutions look to cross-institutional partnerships and consortia as a way to possibly reduce costs or gain efficiency. Purchasing consortia are a good example. In a purchasing consortia, similar institutions develop a contractual relationship that allows for collective cost savings and the opportunity to work more closely with system and software vendors. Other consortia are employing their collective strengths to develop applications, purchase and produce educational content, and build out and enhance data collection and analytics capabilities. Still others are combining their resources in service to a collective strategic goal, such as student success and the improvement of completion rates. The potential of higher education consortia to further the agenda of the next-generation digital learning environment was identified in the EDUCAUSE white paper on this topic.

- Changing faculty roles (focus on advising and student success, growth in adjuncts, etc.). Prompted by sociological, technological, and economic forces, the role of the faculty member in higher education has significantly transformed over the past 20 years. New instructional models and the innovative use of technology have resulted in faculty serving as coaches, software developers, advisors, and instructional leads to sizable cohorts of adjunct faculty. Team-developed courses and demands for increased access to education that can be delivered in various ways have led to an increased focus on the quality of instruction and the rise of the instructional design profession. In his paper on the unbundling of the faculty role, Vernon Smith points to the disaggregation of faculty work to include teaching, course design, assessment, and advising. The faculty transformation continues as an evolving competitive workplace and rising higher education costs place new demands on the relevance of higher education.

- Digitization of scholarly and research data (data management, visualization, discipline-specific tools, etc.). Data today are typically produced in a digital format and increasingly are being used, manipulated, and studied in scholarship and research in digital ways. It is essential that data management practices are updated to be able to work with digital data throughout its life cycle. Higher education IT must also be aware of and able to provide researchers with the necessary tools and resources to work with and manage these data, including discipline-specific tools and practices, data visualization, research support for both traditional and more nascent areas of study (such as digital humanities), interdisciplinary research support, and more.
- Changing vendor-institution relationships (bypassing IT to work directly with business-area leaders). As cloud-based services become increasingly common, individual departments are often negotiating directly with vendors and bypassing IT departments to select and purchase technology-related services. This practice makes it difficult for IT staff to maintain standards for architecture and integration, and it complicates concerns for information security, compliance, privacy, data management, and data governance. IT departments are responding in part by developing expertise in relationship-management skills, allowing them to communicate better with both campus stakeholders and the vendor community.

The remaining two trends were of limited impact in our research: institutional international strategies (international campuses and partnerships, internationalization of student body, etc.), and adaptive learning.

**The Technologies**

The list of strategic technologies included in our survey was derived from the 2016 list and from several authoritative sources that annually identify emerging and maturing technologies in higher education. A total of 29 of the technologies in the survey pertain to teaching and learning. For each of those technologies, respondents selected one of six response options to indicate the level of activity for that technology at their institution in 2017:

- **Institution-wide deployment**: Full production-quality technical capability is in place, including ongoing maintenance, funding, etc., with deployment potentially supporting institution-wide access.
- **Expanding deployment**: In 2017, we will move from initial or partial to broader or even institution-wide deployment.
- **Planning, piloting, initial deployment**: This technology is not yet available to users; however, meaningful planning for deployment is either in development or in place. Staff are investing significant time (multiple person-weeks of effort) and resources in executing the plan to pilot or deploy this technology within a defined time frame.
- **Tracking**: Multiple person-days of effort will be assigned but restricted to monitoring and understanding this technology (much more than just reading articles).
- **No deployment**: None of this technology is in place, and no work will be under way or resources committed for this technology in 2017.
- **Don’t know**: I don’t know what this technology is.
We assigned attention scores to the responses, and the scores were weighted to highlight responses indicative of higher levels of activity (expanding deployment; planning, piloting, initial deployment; and tracking) over responses that suggest little or no activity of that kind (institution-wide deployment, no deployment, and don’t know).

Understanding what peer institutions (both current and aspirational) are doing can help you gauge whether your institution’s current approach is on track or might warrant reconsideration. Some technologies are more relevant for some types of institutions than others. We looked at broad demographic categories, including Carnegie class, institutional size, and approach to technology adoption and found differences in attention score based on those factors. In figure 1, the U.S. mean is the average attention score for an item from all U.S. respondents. The minimums and maximums are the lowest and highest average attention scores among all groups within the categories of Carnegie class, institution size, and timing of technology adoption, with labels indicating which group or groups returned that score. In the event of a tie, all tied groups are represented.
### Figure 1. Attention score averages and differences

<table>
<thead>
<tr>
<th>Category</th>
<th>Minimum</th>
<th>U.S. Mean</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active learning classrooms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technologies for improving analysis of student data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorporation of mobile devices in teaching and learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses of APIs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technologies for planning and mapping students’ educational plans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technologies for triggering interventions based on student behavior or faculty input</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technologies for offering self-service resources that reduce advisor workloads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile app development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open educational resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technologies for degree auditing (documenting and tracking students’ educational plans)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Courseware</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technologies for integrating student records data across case management systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT accessibility assessment tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predictive analytics for learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Next-generation LMS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptive learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iPASS (Integrated Planning and Advising for Student Success) technologies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predictive learning analytics (course level)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Games and gamification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote proctoring services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses of the IoT for teaching and learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital microcredentials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual reality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Text/content analytics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional support for speech recognition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Augmented reality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integration/uses of machine speech recognition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Affective computing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blockchain</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**: 
- **DR pub.** = Doctoral Public Institution 
- **DR priv.** = Doctoral Private Institution 
- **MA pub.** = Master’s Public Institution 
- **MA priv.** = Master’s Private Institution 
- **BA** = Bachelor’s Institution 
- **AA** = Associate’s Institution 
- **Non-U.S.** = Non-U.S. Institutions
Looking beyond attention scores, we sought to understand the kind of effort that the largest proportion of institutions is devoting to each technology. We created four attention categories by combining adjacent responses:

- Expanding deployment and institution-wide deployment, combined as **deploy and maintain**
- Planning, piloting, initial deployment and expanding deployment, combined as **pilot and deploy**
- Tracking and planning, piloting, initial deployment, combined as **decide and plan**
- No deployment and tracking, combined as **track and learn**

Although nearly every technology was represented to some degree in each attention category, we assigned each technology to the attention category with the greatest amount of institutional activity for that technology in 2017.

**Complete initial deployment and maintain these technologies.**

Our research shows that institutions are planning to **deploy and maintain** one teaching and learning technology:

- **Technologies for integrating student records data across case management systems.** These technologies bring together data—which may exist in multiple systems—relating to each specific student. They make the data available to any staff or faculty member approved to access the information, allowing them to see all the data in the student record that is appropriate for their use. This access gives those responsible for student support up-to-the-minute information and enables them to collaborate to ensure student success.

**Pilot and start deploying these technologies.**

At this time, institutions are planning to **pilot and deploy** these teaching and learning strategic technologies (listed below from highest to lowest attention):

- **Active learning classrooms.** Active learning classrooms (ALCs) “typically feature round or curved tables with moveable seating that allow students to face each other and thus support small-group work. The tables are often paired with their own whiteboards for brainstorming and diagramming. Many tables are linked to large LCD displays so students can project their computer screens to the group, and the instructor can choose a table’s work to share with the entire class. Wireless Internet plays an important role in retrieving resources and linking to content management systems, and depending upon the size of the room, table microphones can be critical so that every student’s voice can be broadcast across the room.” In practice, considerable variation in the levels and combinations of low and high
technology persist due to costs, infrastructure, and goals. Regardless, the principles governing room layout/design, furniture, technology, and other features are that of active learning pedagogical approaches. The Learning Space Rating System (LSRS), from the EDUCAUSE Learning Initiative, is a tool to assess the design of ALCs.

- **Incorporation of mobile devices in teaching and learning.** Incorporation here means the deliberate and explicit integration of mobile devices in the fabric of a course’s design or set of learning activities. At its most basic level, this kind of integration entails explicit planning to ensure that course resources and activities are accessible to students using mobile devices. At a more ambitious level, the designs of course content and learning engagements deliberately target the use of mobile devices by leveraging their unique capabilities. Mobile devices, once so integrated, can be used for course assignments and fieldwork but also as tools to facilitate collaboration for all participants.

- **Uses of APIs.** An application programming interface (API) defines how a system interacts with other systems and how data can be shared and manipulated across programs. A good set of APIs is like building blocks that allow developers to more easily use data and technologies from various programs. APIs are used in many ways in higher education—for example, to pull data from the student information system into the learning management system, to integrate cloud-based with on-premises services, as an approach to security, and to access web-based resources.

- **Technologies for planning and mapping students’ educational plans.** Educational planning tools allow students and advisors to work together to build customized pathways through the curriculum that are appropriate for each individual’s interests and goals. In addition, these technologies offer a reliable way to chart and track progress toward a degree or credential completion. They also support institutions in the development of schedules that match demand.

- **Technologies for triggering interventions based on student behavior or faculty input.** These applications gather data points from a variety of institutional and academic systems, sending communications to students, faculty, advisors, and administrators in support of early intervention. They also provide a holistic view of a student’s progress, allowing the provision of targeted assistance in support of individual needs.

- **Mobile app development.** Mobile app development (responsive design, hybrid, etc.) is the organizational capability for the development of mobile applications. Organizations must make decisions about native apps for specific devices and mobile web development strategies. Issues of accessibility, security, data protection, and responsive web design also must be addressed when considering mobile app development.
Technologies for degree auditing (documenting and tracking students’ educational plans). An application used for degree auditing facilitates analysis of the academic program, comparing the requirements that must be met with what the student has completed and thus guiding the student to the requirements remaining to be met in order to complete a credential.

Decide when these technologies fit your strategy, and start planning. Institutions are carefully watching these five teaching and learning strategic technologies (listed below from highest to lowest attention), deciding and planning for potential future deployment:

- **Technologies for improving analysis of student data.** These technologies enable immediate access to and rapid analysis of large, complex data sets, making it possible to discern trends in students’ engagement with college, in the types of difficulties students are encountering, and in their likely success in attaining credentials across the student body. These technologies allow advisors, student services staff, and administrators to examine broader patterns across departments, divisions, schools, demographics, financial aid status, or other categorizations of interest and adjust strategies accordingly.

- **Technologies for offering self-service resources that reduce advisor workloads.** These platforms make tools such as online registration, scheduling, and academic planning available directly to students, enabling those with professional responsibilities for guiding them to reserve in-person appointments for higher-level interactions and counseling on individual issues.

- **Open educational resources (OER).** OER are freely accessible, openly licensed documents and media that may be useful for teaching, learning, and assessing, as well as for research purposes. OER are used in various learning settings to include online, face-to-face, and blended, as well as structured learning environments like college courses and self-paced, learner-driven learning.

- **Courseware.** At its most general level, courseware is any digital curricular resource that contains a blend of content, study aids, and instructional expertise. Courseware is typically housed and delivered by a digital platform or application. Courseware’s content is a direct descendent of the textbook, and the study aids might include tools such as highlighting, commenting, and ways to interact with learners and instructors. Courseware that contains more sophisticated instructional (or tutoring) capability is often called adaptive courseware or adaptive learning technology.
Next-generation LMS. This strategic direction breaks from the preoccupation with the learning management system (LMS). It replaces that preoccupation with a focus on the next-generation digital learning environment (NGDLE) and asks instead how such an environment can enable student and instructor success. With respect to its digital architecture, it espouses a component-based approach, one in which the apps or components are woven into a coherent environment by means of open standards. From a learner and instructor perspective, the key requirement for this new digital learning environment is personalization and customization, which can only be achieved with a component-based architecture utilizing open standards. The functional domains of primary importance for the NGDLE are interoperability, personalization, collaboration, accessibility, and analytics (which includes student advising).

Learn about and track these technologies.
Institutions are tracking and learning about the following teaching and learning strategic technologies (listed below from highest to lowest attention):

- **IT accessibility assessment tools.** IT accessibility assessment tools allow institutions to test the designs of their web pages and other online materials to ensure they are usable by individuals with disabilities.

- **Predictive analytics for learning.** Predictive learning analytics is “the statistical analysis of historical and current data derived from learners and the learning process to create models that allow for predictions that improve the learning environment within which it occurs.”

- **Adaptive learning.** Adaptive learning is one dimension of personalized learning, which aims to provide efficient, effective, and customized learning paths to engage individual learners. Adaptive learning technology dynamically adjusts to student interactions and performance levels, delivering the types of content in an appropriate sequence that individual learners need at specific points in time to make progress.

- **iPASS (Integrated Planning and Advising for Student Success) technologies.** At its core, iPASS, or technology-enabled advising, uses technology to support broader reforms within the advising and student support function of higher education institutions. Ideally, iPASS uses technology to promote, support, and sustain long-term holistic advising relationships. Using technology enables personnel throughout the institution to engage in advising and student support relationships that approach student support as a teaching function; touch students on a regular basis; and connect them to the information and services they need when they need them, in order to keep students on track to completion.
- **Predictive learning analytics (course level).** Predictive learning analytics is the educational application of analytics by gathering and analyzing details of student interactions in online learning activities. At the course level, the information gleaned can then be used to adjust class activities and coursework to address areas where students may need more or less help.

- **Games and gamification.** Gamification or game-based learning refers to the use of a pedagogical approach that utilizes gaming designs and principles but that is implemented within a non-game context, such as an instructional setting. Gamified learning environments are meant to support learner engagement and motivation, problem-solving, critical thinking, and decision-making skills development.

- **Remote proctoring services.** Remote proctoring allows students to take an assessment at a remote location while ensuring the integrity of the exam. Online education, in particular, faces the challenge of conducting trustworthy assessments at a distance. Though some institutions use testing centers or require that students come to campus for exams, a growing range of digital tools endeavor to fill this need. These might include a web-based service that provides synchronous remote monitoring by a human being or a video recording of student behavior during a test. The twin goals of all such systems are to ensure that people taking tests are the people they claim to be and that test-takers do not cheat during the exam.

- **Uses of the IoT for teaching and learning.** The Internet of Things refers to the network of small, often everyday objects equipped with both computing and sensing capabilities, as well as the capacity to send and receive data via the Internet. There are two dimensions to the curricular use of the IoT: first, as a way of providing learning data about student activities, and second, as a source of student projects in disciplines such as computer science and engineering. Via makerspaces, the IoT may also be a domain of student extracurricular activity.

- **Digital microcredentials.** A digital microcredential is a like a mini-degree or certification that conveys information about a competency or skill related to a specific topic area that has been developed by the earner. Digital microcredentials or digital badges can be issued by anyone and typically contain detailed metadata that communicates what the learner has learned or is able to do as a result of earning the credential.

- **Virtual reality.** Augmented reality (AR) and virtual reality (VR) are experiencing a renaissance in higher education. Both technologies have been around for some time; AR first appeared in the Horizon Report in 2005. Along with blockchain, virtual and augmented reality is the buzz technology in the domain of teaching and learning. This renewed interest is being driven by the reduced cost of the hardware (such as headsets) and
by the fact that some of the headsets can be driven by mobile devices. Hence
the digital divide for this technology has appreciably narrowed, making it
possible to imagine its use in more academic disciplines. This new round
of experimentation has two pedagogical dimensions: first, as an experience
consumed by the learner (e.g., anatomy in medical education), and second, as
a programming exercise whereby the learner creates AR and VR experiences.

- **Text/content analytics.** Text/content analytics is a set of techniques and
  processes that analyze unstructured, text-based information to discern
  themes and patterns that can be used as data for analysis and decision
  making.

- **Institutional support for speech recognition.** According to the Gartner IT
  Glossary, speech recognition systems interpret human speech and translate
  it into text or commands. Institutional support for such technologies may
  focus on straightforward educational applications (e.g., language learning)
  or improving accessibility for students who are blind or physically disabled
  or have a learning disability.

- **Augmented reality.** Augmented reality (AR) is technology that supplements
  or augments the user’s view of the real world with overlays that convey
  additional sensory input, information, and perspectives. AR is delivered
  to the user by means of a variety of display devices, including eyeglasses,
  headsets, smartphones, contact lenses, and even direct retina scans.

- **Integration/uses of machine speech recognition.** According to the Gartner IT
  Glossary, speech recognition systems interpret human speech and translate
  it into text or commands. The integration/uses of such technologies may
  focus on straightforward educational applications (e.g., language learning)
  or improving accessibility for students who are blind or physically disabled
  or have a learning disability.

- **Affective computing.** The term affective computing “refers to IT systems and
devices designed to discern human emotions, respond to the user on the
basis of what they perceive, and, in some cases, represent human emotion
to users. Unlike ‘conventional’ computing, in which computers only ‘know
what they are told,’ affective computing strives to ‘infer’ or ‘read’ a user’s
emotional state, adding a qualitative component to interactions between
humans and computers.”

- **Blockchain.** Blockchain is a public, distributed ledger of transactions
maintained by a peer-to-peer network. Its most notable current use is to
support value exchange with Bitcoin. In teaching and learning, it is the
leading candidate technology to support the next-generation transcript, one
that could capture the full range of educational experiences in detail and
could document a person’s lifelong learning accomplishments.
Preparing for the Future

Understanding the technologies that are most relevant for your institution and how fast a certain strategic technology may be growing is critical to institutional IT strategy. We estimated the pace of growth based on the percentage of institutions we predict will implement each technology over the next five years (by 2022). Figure 2 positions each technology in one of 12 cells based on institutional intentions (the “recommendation for today”) and the expected pace of growth of that technology. Reflecting what was noted above, the figure shows that most of the technologies we tracked are still being explored—rather than deployed—by most institutions.

<table>
<thead>
<tr>
<th>Recommendation for today</th>
<th>Expected pace of growth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deploy and maintain</strong></td>
<td>Slow, Moderate, Fast</td>
</tr>
<tr>
<td>• Technologies for integrating student records data across case management systems</td>
<td></td>
</tr>
<tr>
<td><strong>Pilot and deploy</strong></td>
<td>Slow, Moderate, Fast</td>
</tr>
<tr>
<td>• Mobile app development</td>
<td>• Active learning classrooms</td>
</tr>
<tr>
<td>• Incorporation of mobile devices in teaching and learning</td>
<td>• Technologies for planning and mapping students’ educational plans</td>
</tr>
<tr>
<td>• Uses of APIs</td>
<td>• Technologies for triggering interventions based on student behavior or faculty input</td>
</tr>
<tr>
<td>• Technologies for degree auditing (documenting and tracking students’ educational plans)</td>
<td></td>
</tr>
<tr>
<td><strong>Decide and plan</strong></td>
<td>Slow, Moderate, Fast</td>
</tr>
<tr>
<td>• Technologies for improving analysis of student data</td>
<td>• Technologies for offering self-service resources that reduce advisor workloads</td>
</tr>
<tr>
<td>• Technologies for offering self-service resources that reduce advisor workloads</td>
<td>• Open educational resources</td>
</tr>
<tr>
<td>• Technologies for planning and mapping students’ educational plans</td>
<td>• Courseware</td>
</tr>
<tr>
<td>• Technologies for triggering interventions based on student behavior or faculty input</td>
<td>• Next-generation LMS</td>
</tr>
<tr>
<td>• Technologies for degree auditing (documenting and tracking students’ educational plans)</td>
<td></td>
</tr>
<tr>
<td><strong>Track and learn</strong></td>
<td>Slow, Moderate, Fast</td>
</tr>
<tr>
<td>• Uses of the IoT for teaching and learning</td>
<td>• IT accessibility assessment tools</td>
</tr>
<tr>
<td>• Digital microcredentials</td>
<td>• Predictive analytics for learning</td>
</tr>
<tr>
<td>• Virtual reality</td>
<td>• Adaptive learning</td>
</tr>
<tr>
<td>• Text/content analytics</td>
<td>• iPASS (Integrated Planning and Advising for Student Success) technologies</td>
</tr>
<tr>
<td>• Institutional support for speech recognition</td>
<td>• Predictive learning analytics (course level)</td>
</tr>
<tr>
<td>• Augmented reality</td>
<td>• Games and gamification</td>
</tr>
<tr>
<td>• Integration/uses of machine speech recognition</td>
<td>• Remote proctoring services</td>
</tr>
<tr>
<td>• Affective computing</td>
<td></td>
</tr>
<tr>
<td>• Blockchain</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Plans for 2017 and pace of growth for teaching and learning strategic technologies
Conclusion

It is no surprise to see active learning classrooms “leading the pack” by being on the fast track for deployment. As the new course models (e.g., flipped and all the various modalities of blended learning) see increasing adoption, the classroom is rapidly shedding its role as a place of lecture and is being reinvented as a place of interactivity. Hence demand for rooms with designs that support active learning will only increase. Tools such as the ELI Learning Space Rating System (LSRS) can assist campus-wide efforts to refocus learning spaces to meet the new instructional paradigms.

One characteristic that is increasingly important for educational technologies is interdependence. The IT architectures for learning are increasingly characterized by the connections they enable. From an IT perspective, this means that the advantages the technologies can afford won’t be realized until they are integrated and act in concert. For example, iPASS is dependent on technologies for student educational planning and for degree auditing. It is further dependent on the same data that enable predictive analytics for learning, as well as on technologies for improving the analysis of student data. A second example is the next-generation LMS, which will require the use of open standards to interconnect the LMS with all the other applications and digital components needed by our faculty and students.

These interdependencies make it clear that perhaps the overarching trend with respect to educational technology is that we are moving away from viewing it as a collection of technologies toward viewing it as a digital learning environment or even ecosystem. To successfully support the teaching and learning mission, we will need to be thinking architecturally about connected technologies operating in concert. The LMS, by itself, cannot get us there. As we move forward, we will need to think in terms of a digital learning environment in which a mix of interconnected technologies is orchestrated to create an integrated and enabling environment that supports the teaching and learning mission.
Notes

1. EDUCAUSE tracks these types of established technologies in the Core Data Service because they are widespread enough to enable institution-level benchmarking.

2. Primary sources were The Horizon Report, Gartner’s Top 10 Strategic Technology Trends for 2014, and multiple 2014 Gartner Hype Cycles (education, big data, cloud computing, cloud security, enterprise architecture, enterprise information management, GRC, identity and access management, IT operations management, privacy, business intelligence and analytics, and emerging technologies). We augmented those with several additional technologies, most notably in analytics.


6. For more information about the use of blockchain in higher education, see *ELI 7 Things You Should Know About Blockchain* and *ELI 7 Things You Should Know About the Evolution of the Transcript*.
