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Hype Cycle for Education, 2016

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The digitalization of education is gaining momentum and moving into execution mode. The CIO faces an increasing number of choices, and this Hype Cycle offers a "CIO toolbox" for the next five years and beyond.

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What You Need to Know

The digitalization of education is gaining more mind share of academic and school leadership. This is putting higher pressure on education CIOs to show how they can contribute to the core mission of education and research, and thereby create a competitive advantage. However, the full advantage of digitalization requires a concerted change in people, process and technology, which makes IT a team sport. IT can no longer be expected to come up with the right solution in isolation. This requires tools for leadership collaboration and a common context to drive change. Each stakeholder needs to express expectations, needs and outcomes in a common language that helps the team identify and execute on the right solutions.

In this puzzle, there is no "one size fits all" set of technologies, and the CIO, along with the institutional leadership, must make well-informed choices that are a fit for several parameters, such as the institutional business model, geography and faculty readiness. Fortunately, there is a basic logic to the digitalization of education. It first requires the digitization of a lot of analog assets and capabilities, and it can be done piece by piece — and sometimes even tool by tool. For example, this can be approached as a series of digital education moments that visualizes the many components that need to go from an analog state to a digitized state, which then enables new, fully digitalized ways of executing on the institution's mission.

This Hype Cycle offers a concrete example of a "CIO toolbox" of discrete "technologies" for the creation of services in the next five to 10 years, and gives many examples of the technology-related tools that Gartner believes are crucial for a CIO to track. More importantly, the Hype Cycle provides a methodology for building a shortlist of interesting technologies to watch, and helps to separate hype from reality, thereby supporting a dialogue between institutional leadership, faculty, students and staff members (see "Toolkit: Connect the Dots to Engage Education Stakeholders in Technology Strategy").

However, the ultimate selection and timing must be driven by "business" needs, the institution's strategy and the business model. To help institutional leadership (in general) and CIOs (in particular) achieve this, Gartner has published a set of research and Toolkits to visualize future options for informing institutional strategy, and to evaluate their implications for IT investment priorities. For example, see:

- "Top 10 Business Trends and Strategic Technologies Impacting Higher Education in 2016"

- "Visual Strategic Planning Using the Gartner Higher Education 'Business Model' Scenarios and Corresponding Strategic Technology Maps"
- "How CIOs Can Use Strategic Technology Maps to Help Build and Execute Strategy for Digital Moments"
- "IT Market Clock for Higher Education, 2015"

This Hype Cycle and the research listed above are tools that can be used separately, but we see a strong synergistic effect when they are used together. CIOs who use all six tools have a way to improve their ability to communicate with the institution's leadership, and to stress the impact of technology early and throughout the strategic planning process.

The Hype Cycle

With the expanding education ecosystem, an increasing number of players are impacting the traditional way of executing the core common mission (to educate), leading to more crossovers of technologies, services and methodologies between the two levels of education (K-12 and higher education), as well as new education formats (such as competency-based education and adaptive learning for traditional as well as nontraditional learning). We also see a surge of innovators and venture capitalists trying out many different business models that are aimed at K-12, higher education and the general consumer. We note the increasing need to define standards, such as grades and learning metadata, in the whole education ecosystem in order to enable the seamless mobility of students and their achievements. We also see an increasing need for higher education institutions to understand what skills and expectations the prospective students are bringing with them, as well as what future employers expect from graduates who are entering the workforce.

The 2016 Education Hype Cycle is characterized by two main trends: (1) from digitization to digitalization; and (2) from infrastructure to exostructure. An increasing number of seemingly low-tech "digital interfaces" — such as Bluetooth Beacons, Virtual Reality/Augmented Reality Applications in Education and Robotic Telepresence — are leading to increasing the available data about learners as well as new ways to engage them. In turn, this is driving the use of Institutional Analytics, Learning Analytics, Adaptive Learning Platforms, Student Retention CRM and Big Data in Education — all of which have the potential to fundamentally change (that is, digitalize) the way the institution works.

A key enabler for true digitalization is the second trend, exostructure. More digitized tools and data sources mean a greater need for integration toward the wider education ecosystem to overcome internal skills deficits and/or to increase the speed of implementation. In particular, the speed needed to successfully compete in the expanding ecosystem comes from more traditional exostructure entries, such as Integration Brokerage and IDaaS, and from more potentially disruptive exostructure entries, such as a combination of Blockchain in Education, SIS International Data Interoperability Standards and Open Microcredentials.

These trends increase the importance of the education CIO's role even more, because all these truly digitalized capabilities are heavily intertwined with the institution's core missions: to educate and (also for several institutions) to research.

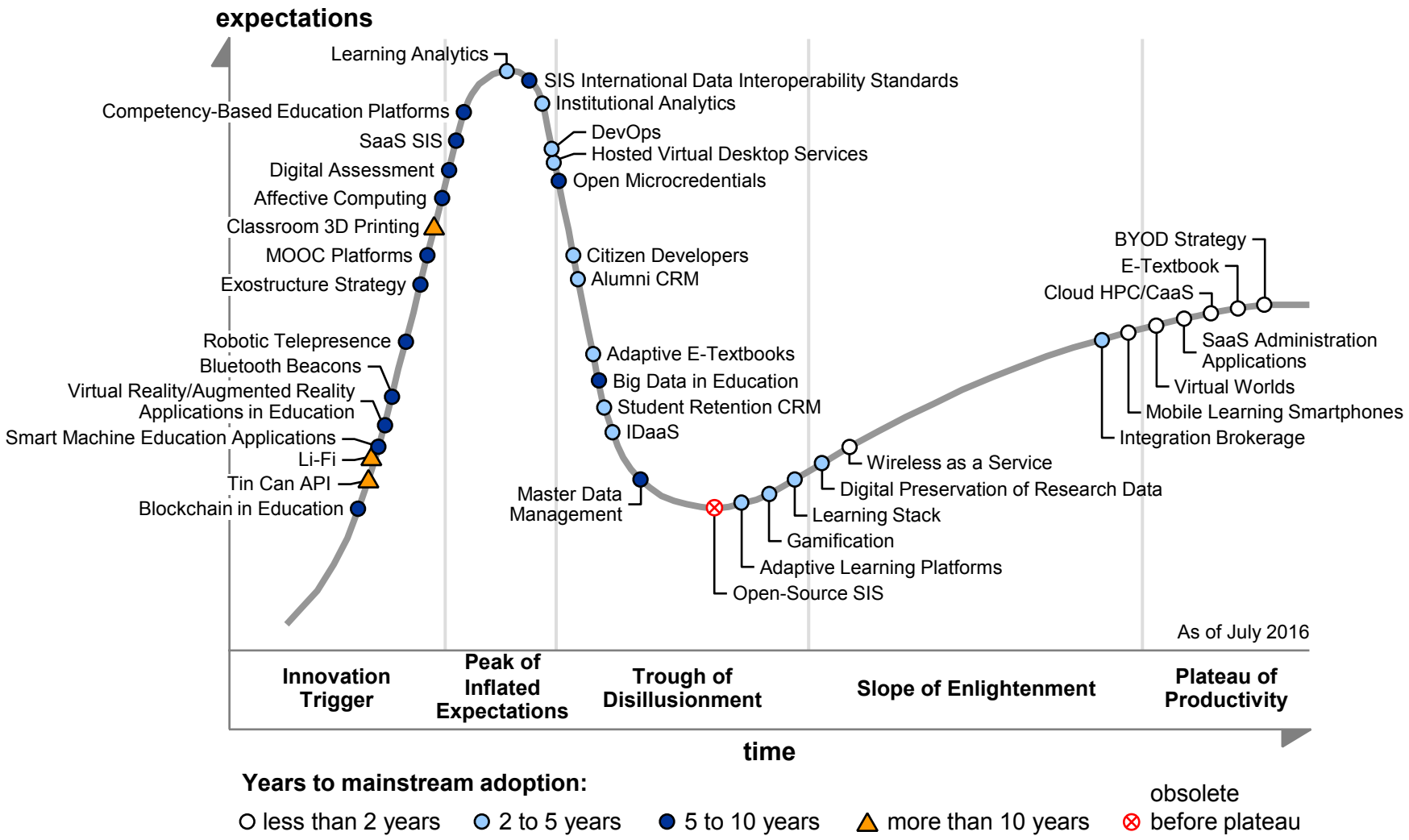
We strongly recommend using the Gartner Hype Cycle Toolkit that is usually published in Q3 or early Q4 every year (for example, see "Toolkit: My Hype Cycle, 2015"). This Toolkit contains all technologies from all Hype Cycles in the current year.

Of the 50 technologies in the 2015 Education Hype Cycle, several key technologies have made progress, and 18 have disappeared altogether or been supplanted by more relevant technologies. Five technologies have changed their names to emphasize a more focused definition. Adaptive Learning and MOOC-Enabling Technologies are now Adaptive Learning Platforms and MOOC Platforms, respectively, to highlight the maturing platform nature in these fields. Hosted Virtual Desktops is now Hosted Virtual Desktop Services to highlight its increasing exostructure nature. Virtual Environments/Virtual Worlds is now simply Virtual Worlds to separate it from the new wave of Virtual Reality/Augmented Reality Applications in Education. Finally, Cognitive Computing Education Applications is now Smart Machine Education Applications in order to align with Gartner's nomenclature in this field.

There are eight new entries:

1. Blockchain in Education tracks the potential of a new "open ledger" for credentials in the education ecosystem.
2. Li-Fi tracks an existing network technology that has the potential to support classroom-based technology reform by combining massive transfer speeds as well as an Internet of Things (IoT)-type of personalized data collection and dissemination from and to students.
3. Virtual Reality/Augmented Reality Applications in Education tracks a new wave of 3D-related technologies that has great promise in pedagogy.
4. Bluetooth Beacons tracks a consumerized IoT technology that helps collect data about students in a specific physical context, as well as push data back based on that physical context.
5. Robotic Telepresence tracks a simple plug-and-play telepresence technology that allows greater control to the remote learner while allowing faculty members to stick to traditional classroom pedagogy.
6. Institutional Analytics is the collection and analysis of data with the goal of improving institutional services and business activities.
7. Identity and Access Management as a Service (IDaaS) tracks a key exostructure capability that is fundamental to any digitized service delivery, and that, in itself, is increasingly mature as an exostructure service.
8. Integration Brokerage, although relatively mature in general, is included to highlight the increasing need for interoperability in the education ecosystem, thereby leading to this service being available as an exostructure service as well.

Figure 1. Hype Cycle for Education, 2016



Source: Gartner (July 2016)

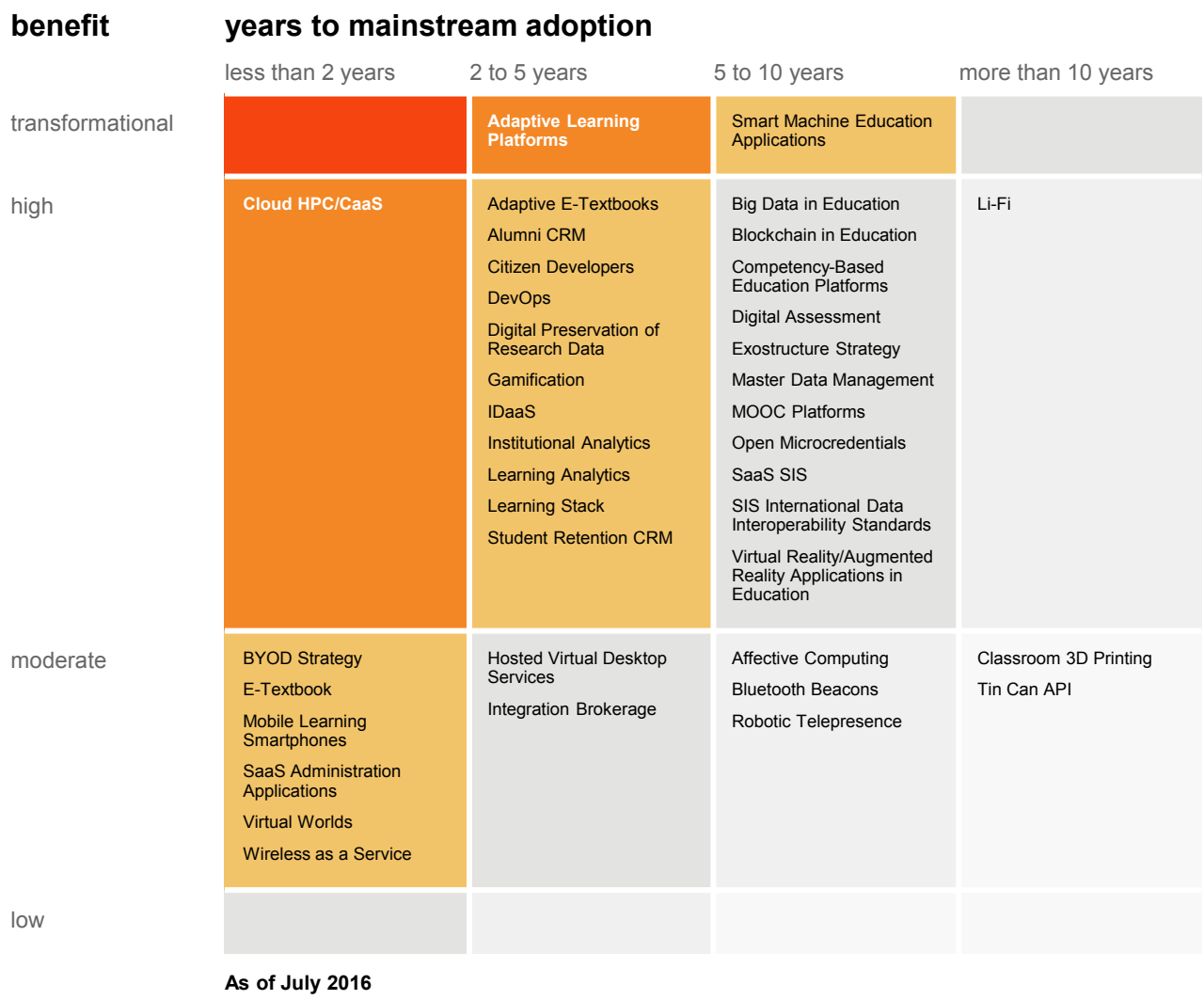
The Priority Matrix

The Priority Matrix for this Hype Cycle is more nuanced and context-dependent than those of most nonindustry Hype Cycles. The reason why is because the benefit ratings can vary substantially, depending on the different types of institutions. Furthermore, we intentionally use entries from nonindustry Hype Cycles (such as IDaaS from the "Hype Cycle for Identity and Access Management Technologies, 2016") in order to relate to their overall standing in maturity and adoption, even outside the education community. The specific institutional context and the general hype/maturity aspect are very important in the assessment of when these technologies are "ubiquitous" enough to build new services or curricula on top of them. This means that the benefit rating in this research is not normalized to any specific type of institution, and, more importantly, some technologies have benefit ratings that are relative to their niche technology category. The result can be seen in the benefit ratings, such as high for DevOps, while the rating for E-Textbook is only moderate. In the first case, the rating is due to the relative benefit to an internal IT organization in meeting the digitalization demand. In the second case, the rating is relative to the original expectations for e-textbooks, and to the competing alternative (Adaptive E-Textbooks) and its importance to the core mission of education.

In this context, Adaptive Learning Platforms and Smart Machine Education Applications are rated transformational for their ability to bring education in a new form to new learners, building on vast amounts of data that can help make a direct, positive impact on learning for the individual student, thus contributing directly to the core mission: education.

To help clients determine which key investments in IT will be most strategic in positioning their institutions for long-term success, we have developed a complementary tool to the Hype Cycle called the Strategic Technology Map (see "Strategic Direction and Timing in Education: Mashing Up the Strategic Technology Map and the Hype Cycle" and "Toolkit: Speed Up Your Innovation Process by Creating Interactive, Prioritized Strategic Technology Maps From the Education Hype Cycles"). The Strategic Technology Map makes it clear that achieving success is seldom about individual technologies or even singular chains of dependencies; rather, it is really about an ecosystem of technologies that must be mature enough to support the institution's strategy. The Strategic Technology Map can help identify the strategic parts of the ecosystem and its interdependencies, while the Hype Cycle provides crucial information about the weakest link in the ecosystem, thereby leading to better analysis of the timing of the "tipping point." If these tools also are combined with business model scenario planning (see "Visual Strategic Planning Using the Gartner Higher Education 'Business Model' Scenarios and Corresponding Strategic Technology Maps"), then a sustainable, uniquely adapted and agile technology strategy can be devised for each institution.

Figure 2. Priority Matrix for Education, 2016



Source: Gartner (July 2016)

Off the Hype Cycle

Eighteen technologies have been removed from this year's Hype Cycle:

- The following 10 technologies have been retired: Personal Analytics, Digital Workplace Graph, Quantum Computing, BPO, Education Tablet, COBIT, ITIL, Enterprise Mobile App Stores, EA Frameworks and Enterprise Architecture. Although they are still of interest to some education CIOs in order to round out their toolboxes, they did not make the cut in this year's Education Hype Cycle.
- Six technologies — IT Infrastructure Utility, 802.11ac Wave 1, Open-Source Enterprise Service Bus, Cloud Office, Unified Communications and Collaboration, and Lecture Capture and Retrieval Tools — are off the Hype Cycle because they are established in the education

community and are well into the Plateau of Productivity (in general market penetration and maturity).

- Social Learning Platform for Education is off the Hype Cycle because it is established in the education community as a concept that needs to be considered for any learning platform, even if it did not reach status as a separate platform in itself.
- Higher Education Open-Source Financials is off the Hype Cycle because we deemed it "obsolete before plateau" in 2015.

On the Rise

Blockchain in Education

Analysis By: Jan-Martin Lowendahl

Definition: Blockchain is a type of distributed-ledger in which value-exchange transactions (in bitcoin or other token) are sequentially grouped into blocks. Each block is chained to the previous block and immutably recorded across a peer-to-peer network, using cryptographic trust and assurance mechanisms. Depending on the implementation, transactions can include programmable behavior.

Position and Adoption Speed Justification: In education, a blockchain/distributed ledger is associated foremost with ideas related to a new ecosystem for secure certified credentials. Specifically, the combination of open microcredentials and blockchain is gaining traction. In this context, credentials are seen as an education "currency," and there is therefore good logic behind the application of the distributed ledger concept.

In education, one of the first examples of blockchain use in credentialing comes from the University of Nicosia in Cyprus. Its approach, based on using the SHA-256 bitcoin algorithm to hash certificates and certificate indexes, illustrates some of the benefits and drawbacks in using blockchain to verify credentials. This first-generation use of blockchain-based credentialing is obviously labor-intensive and requires significant IT skills, even if it does provide trustworthy and durable credentials that would exist even if the University of Nicosia's records disappear. It is also important to note that the blockchain does not set any standard for how a credential is expressed (as Europass attempted), it only makes a digital credential (or digital asset of any kind) globally accessible, trustworthy and durable. This means that specific standards would still have to be developed to allow for interoperability.

Since this early example, several institutions have experimented or plan to issue blockchain-based credentials. Massachusetts Institute of Technology (MIT), Ecole Supérieure d'Ingénieurs Léonard de Vinci (ESILV), Holberton School and even Sony Global Education represent different ways to apply the blockchain technology to credentials. MIT does it on its own (in a manual process similar to that above), using private keys and hashes for each certificate. Through its recognition in academia, it helps promote the blockchain approach. ESILV and Holberton School use partners (Paymium and

Bitproof, respectively) to improve the process for issuing credentials, and they represent the most likely way forward for majority education institutions.

It is still early days for both blockchain and open badges, and both technologies need more development to find a sustainable and user-friendly form that combines the best of both. Blockchain is lagging open microcredentials in maturity, and is in the early trigger phase with five to 10 years to the Plateau of Productivity.

User Advice: Blockchain represents a very interesting technology that can help to solve a real problem by making credentials globally accessible, trustworthy and durable. However, producing bitcoin transactions of PDF certificates does not solve the issue of making a credential more understandable to an employer. A combination of blockchain and open badge specifications is a potentially powerful solution. An approximate analogy is that blockchain provides the secure protocol similar to HTTPS, and open badge specifications provide an open, machine-readable and ultimately human-understandable format similar to HTML. The question in hand is how to build a whole digital credentialing ecosystem, and although the CIO has an important role to play this effort must be led by the registrar or similar role, not IT.

Business Impact: Matching people skills and educational attainment with employer needs is a fundamental challenge in the global economy. Although these challenges have always been present, they are multiplied through globalization. A recruiter cannot be expected to know all the worlds' education programs, what the diplomas really stand for and whether students successfully completed programs. The Bologna Process in Europe, where now more than 45 countries try to build a common European Higher Education Area, shows clearly the many challenges in comparing educational qualifications from different countries, and even different institutions. However, just verifying credentials is a relatively trivial use case, and establishing a secure global ledger infrastructure can enable much more value — for students, educational establishments and employers. Sony Global Education represents an interesting use case for blockchain, where it foresees that it is not the final credential that is shared, but the detailed test results themselves. In this scenario, a test-taker/student can share the outcome of a test to one or several "evaluation organizations" that will evaluate and score according to their respective methodology. In a world of algorithmic education (see "Analytics, Assessment and Adaptive Learning Will Prepare You for the Algorithmic Education Evolution") and smart machines, it is easy to see an ecosystem of independent-testing services and evaluator services that can build a brand of objectivity that is separate from the educating institution, and offer more flexible credentialing. This could be an emerging service equivalent of the practice of getting a "second opinion" in healthcare. If this will be reality, all depends on the value relative to the cost, and it has to be highly automated but also has the potential to impact the education ecosystem profoundly.

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Recommended Reading: "Gaining Competitive Advantage in the Education Ecosystem Requires Going Beyond Mere Infrastructure to Exostructure"

"Reinventing Education Credentials Using Blockchain as a Possible Missing Link for the Open Badge Infrastructure"

Tin Can API

Analysis By: Glenda Morgan

Definition: The Tin Can or Experience API (xAPI) is a standard protocol that connects many different varieties of applications with a system to record learning activity that occurs within those applications.

Position and Adoption Speed Justification: In many ways, our models for tracking learning, for learning analytics or the award of microcredentials are based on an assumption that the vast bulk of learning activity is recorded by the learning management system (LMS). The LMS serves as the primary source of data about learning that feeds into these other systems. But LMSs were never the only source or even the primary source of where learning activity happens and this is increasingly true. People learn in all kinds of contexts using all kinds of tools and we need to capture that information.

The xAPI sends statements from applications to a learning record store (LRS) in the form of noun-verb-object (e.g., Jill reads the blog). The LRS can then share these statements with other LRSs as well as other systems to display, analyze and use. This means we can capture learning activities from the full spectrum of formal and informal learning in which students participate. These statements will become key to many areas of educational technology achieving their full potential, especially learning analytics.

The xAPI is a relatively new development and has seen some uptake in corporate learning (for example, LearnDash) but is beginning to be implemented in education, for example, in learning relationship management systems (such as Motivis Learning). This justifies a position in the early trigger phase, but we are beginning to see more adoption and interest. It will take some time for technology vendors to implement this specification and for education users to experiment with and begin to exploit the specification to get real value from analytics, credentialing systems and other initiatives. The time to plateau is thus five to 10 years.

User Advice: CIOs should familiarize themselves with the xAPI specification and include it as an optional component of all RFPs for all technologies with which users interact. Additionally, CIOs should begin to plan the acquisition of a learning record store as part of the learning infrastructure.

Business Impact: The xAPI has the potential to have a very big impact especially in terms of how we understand, analyze and act on student learning. It allows us to capture the full range of learning activities no matter where they happen, which will allow us to design better learning experiences and take action to address learning problems.

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Rustici Software; Saltbox

Recommended Reading: "Cool Vendors in Leveraging Data in Education, 2015"

Li-Fi

Analysis By: Sylvain Fabre

Definition: Li-Fi stands for Light Fidelity. It is part of the optical wireless communications (OWC) technologies. It is analogous to Wi-Fi (it leverages the 802.11 protocols as well) but uses light (visible or infrared and near ultraviolet) rather than wireless radio waves.

Position and Adoption Speed Justification: While it could address some very specific use cases, Li-Fi is still in its infancy; the Li-Fi Consortium (founded in 2011), is a collection of companies and academic research institutions still seeking to create research and investment momentum behind this new technology ecosystem. As an immature technology — with no international standard and no mainstream vendor support or products yet — deployments would rely on low volumes and higher cost components. It is unclear whether it can function well out of doors or with high ambient lights. Li-Fi is aligned with the trend to replace incandescent lights with LEDs, and may enable networking in places where light infrastructure is already present (for example, streetlights). Even if market traction occurs, it would take years for a Li-Fi ecosystem to mature.

User Advice: Consider Li-Fi for Internet of Things (IoT) applications where signals do not need to go through walls (which wireless frequencies can do, but not light) and where range requirements are lower than Wi-Fi. Also suitable for sensitive environments where interference from wireless signals would cause an issue, such as hospitals, or industrial areas with flammable gases where radio frequency (RF) could pose a risk of explosion.

However, Li-Fi faces serious hurdles — it requires a whole new infrastructure, has no meaningful support in client devices, and the vast majority of potential endpoints (such as smartphones and tablets) can be served with gigabit Wi-Fi. The need for a clear optical path between sender and receiver may not function in all places in a room, or if a device and its sensors are covered (by an object or in a bag). This limitation means that Bluetooth, Wi-Fi and cellular would still be needed, as visible light has a much narrower directional availability than wireless radio technologies.

Business Impact: Li-Fi is about a hundred times faster than Wi-Fi with (theoretically) speeds of over 100 Gbps available. There is no cost involved of buying spectrum to operate this technology. Capacity is much higher without the spectrum limitations inherent to wireless operations, licensed (such as Third Generation Partnership Project's [3GPP's] Long Term Evolution [LTE], Long Term Evolution Advanced [LTE-A]) or unlicensed (Wi-Fi), and less contention. Therefore, this could support a very high density of devices in a given area. Li-Fi could prove to be a very useful connectivity alternative for connected things in IoT, such as autonomous vehicles. Integration with existing light infrastructure could result in cost savings (compared to a separate Wi-Fi network). Retrofitting lower speed systems into existing premises may be possible using data over power line networking. For tightly controlled and well-defined areas, Li-Fi could offer increased security. Data

transmission over the existing power line may be necessary in most deployments to avoid additional backhaul and front haul costs, which currently reduce the economic benefits of small cells, for example.

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Sample Vendors: Fraunhofer Institute for Photonic Microsystems (IPMS); IBSENtelecom; pureLiFi

Smart Machine Education Applications

Analysis By: Jan-Martin Lowendahl; Kelly J. Calhoun

Definition: Gartner defines smart machine technologies as adapting their behavior based on experience, not totally dependent on instructions from people (they learn on their own) and able to come up with unanticipated results. In this profile, we look at the use and impact of smart machine applications for K-12 and higher education institutions.

Position and Adoption Speed Justification: The earliest practical impact has been in the medical field where IBM's "Watson for Oncology" application already can help diagnose cancer and suggest treatments together with physicians. In research, the IBM "Watson Discovery Advisor" has aided a research team from Baylor College of Medicine to analyze more than 70,000 articles related to a protein (p53) that has been linked to many cancers and identify six related proteins to target new research — all in a matter of weeks. To try to put this in perspective: An average researcher in the field reads about 23 scientific papers a month, and the average identifications of p53-related candidates have been one a year for the last 30 years.

These examples clearly indicate the profound effects smart machine applications can have on the process and skills of a knowledge profession, whether for a researcher or a practitioner. These applications clearly will need to impact the way we educate our students, helping them race with the machines rather than against them. In doing that, education institutions themselves will have to leverage smart machine applications. It is not far-fetched to imagine Watson as a lifelong tutor, changing the paradigm for education from industrialized one-size-fits-all to digitalized, personalized learning — all while still achieving scalability and affordability.

However, it is not in education itself we see the first impact on students; it is in administrative student services. Deakin is the first education institution to launch a "Watson Engagement Advisor"-powered Student Advisor Application. The three-stage IBM project of which the first stage started in February 2015 and the last in December 2015. The experiences gained from the three stages were (1) established a dialogue (how do you talk to Watson) (2) gave access to institution data (how do you teach Watson about the institution) (3) personalized the conversation (how do you feed Watson personal data). IBM's Teacher Advisor Powered by Watson focuses first on providing insight and analysis to teachers of fourth grade math, guiding them through the process of identifying, selecting and evaluating teaching resources.

There are many potential smart machine applications in education, and they will likely develop at different speeds. Smart machine applications in oncology have already started to yield results. With student services, we see a beginning, and as a general lifelong tutor, it is still just on the drawing board.

For now, we place smart machine applications in education as one profile in the trigger phase with at least five to 10 years to plateau. However, we anticipate that we will need to split it into several profiles with different maturities and speeds to plateau depending on the area of application.

User Advice: The key to success for a smart machine application is the availability and "digestibility" of data. "How do you feed the machine?" should be the first question a CIO asks when contemplating a smart machine application. At present, this implies a need to narrow applications to well-defined fields with a good corpus of data to teach the smart machine. In addition, to be really useful, the smart machine needs to get meaningful individual data in order to be able to provide personalized results.

The medical field exemplified above with oncology has been a natural starting point. Thousands of scientific journals provide a foundation for a smart machine application, and individual medical tests provide a relatively structured output that can result in personalized treatment suggestions.

CIOs should investigate how existing data-rich product/services such as Knewton's Declara, Connexus and Hobsons' Predictive Analytics Reporting (PAR) Framework can provide a data foundation for smart machine applications.

Business Impact: Smart machines touch the core mission of education and research. They have the potential to transform not only the professions we educate for but also education itself. It can be a key contributor to the fundamental question of how we can deliver scalable and affordable quality education to empower all the world's citizens to reach their full potential.

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: IBM

Recommended Reading: "Hype Cycle for Smart Machines, 2015"

"Cool Vendors in Leveraging Data in Education, 2015"

"How to Define and Use Smart Machine Terms Effectively"

"Analytics, Assessment and Adaptive Learning Will Prepare You for the Algorithmic Education Evolution"

Virtual Reality/Augmented Reality Applications in Education

Analysis By: Glenda Morgan; Jan-Martin Lowendahl

Definition: Virtual reality and augmented reality are two different yet related technologies. Virtual reality technologies create computer-generated environments to immerse users in a virtual environment. Augmented reality technologies overlay digital information on the physical world in order to enhance it and guide action.

Position and Adoption Speed Justification: The recent release of new VR and AR platforms and consumer-grade hardware and software, often incorporating use of smartphones and tablets, has resulted in a resurgence in provision of solutions for education and adoption by schools, colleges and universities. There are still challenges in the quality of the technology especially in resolution quality, refresh rates, and voice and emotion recognition. But the emergence of new solutions and adoption by both K-12 and higher education mean a position halfway up the trigger phase. But the technical challenges and the policy and pedagogical obstacles to be overcome mean that it will be five to 10 years before these technologies reach the Plateau of Productivity.

User Advice: Both K-12 and higher education have been anticipating the large-scale adoption and practical use of virtual reality (VR) and augmented reality (AR) tools for some time, going back to the immersive virtual reality cave automatic virtual environment (CAVE) learning environments of the 1990s and 2000s. Those early instances of VR, especially the immersive CAVEs, proved expensive and difficult to manage with relatively few use cases to show benefit.

Use of VR and AR lived on in some environments such as medical schools, which used these technologies to provide access to learning and practice environments such as surgery simulation and VR cadavers for dissection. This new wave of VR and AR applications promises to serve a much broader variety of purposes.

K-12 and higher education institutions will need to decide what platform or platforms they want to standardize on and consolidate their investments in those areas. Given price concerns, users should gain experience implementing and supporting smaller applications of VR before moving on to large immersive classroom-scale applications. Network and cell coverage will need to be strengthened in order to support large-scale use of these tools. CIOs will need to find ways to manage the consumer nature of many of the tools in an enterprise environment but should also not neglect the pedagogical and policy implications of VR and AR and seek solutions to both of these.

Business Impact: The new generation of VR and AR applications and tools promises to support a wide variety of learning activities including:

1. Field trips — allowing users to virtually experience trips to remote and unlikely places including historical settings, for example, the Google field trips using Cardboard.
2. Vocational or practical training — providing simulated experiences or guiding activity with a digital overlay.
3. Collaboration and engaged teaching environments — bringing social and teaching presence into lecture environments.
4. More engaged interaction with content, for example, products such as zSpace, Alchemy VR or IndyLab VR.

VR and AR are also beginning to play a role in areas such as athletics; for instance, for football training, we are likely to see increased adoption of these technologies to support administrative functions and other aspects of the student experience, for example, in campus tours. Research is an obvious area ripe for application of VR and AR but as yet, few applications have emerged to support the research mission of the university.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Alchemy VR; AugThat; Immersive VR Education; Nearpod; zSpace

Recommended Reading: "Market Trends: Head-Mounted Displays for Virtual Reality and Augmented Reality"

"Market Guide for Augmented Reality"

Bluetooth Beacons

Analysis By: Terri-Lynn B. Thayer; Mark Hung

Definition: Bluetooth beacons are Bluetooth Smart (aka Bluetooth Low Energy or BLE) devices that serve as proximity beacons to Bluetooth 4.0-enabled mobile devices, such as smartphones. With BLE's proximity profile, mobile devices and apps can derive their proximity to the beacons at a granularity that may not be possible with other location technologies, especially in an indoor environment.

iBeacon is Apple's proprietary implementation of the Bluetooth LE proximity profile. It includes enhancements such as improved ranging between the devices.

Position and Adoption Speed Justification: The Bluetooth beacon and iBeacon technologies continue to attract significant interest from a variety of industries since it first became available in 2013. Trials and deployments have ranged from professional sports to retail. New applications are also emerging for enterprises such as hospitals, banks and education. Specifically for higher education, solutions are now available from vendors, such as Pink Leopard Software and DTP, that leverage beacons in concert with application software to improve student engagement, success and ultimately retention. These solutions are capable of tracking attendance and the utilization of academic facilities such as labs and libraries. The technology can be used to deliver content directly to students (such as a video link in class) or to campus members (such as building and program information during a campus tour). It may also prove helpful in further engaging students by providing compelling content (such as fan information during sporting events, or coupons for local eateries).

Over the past 12 months, Google has launched its Eddystone beacon protocol to challenge Apple's more established alternative, iBeacon. Eddystone differentiates itself from existing beacon protocols (such as iBeacon and AltBeacon) by removing the need for an app on the smartphone in order to

interact with the beacon — only a browser is required to accept the HTTP messages from the beacon. With this ability to associate URLs with each beacon, Google has promoted this architecture as the "physical web."

Although there is significant momentum behind the technology, most of the current deployments are still at the technology trial stage. Note that vendors are quickly modifying the technology to improve battery life and support new beacon protocols such as Eddystone. Therefore, we expect that significant technology R&D still needs to occur, as well as business cases proven out, before the Bluetooth beacon technology sees widespread adoption in any sector. Some of the early leaders include BKON, Estimote, Gimbal, Kontakt.io, and Radius Networks. More-established technology vendors, such as Cisco, Hewlett Packard Enterprise (Aruba Networks) and Zebra, are also getting into this space. Key to any beacon system is the technology to provide initial physical mapping of beacon locations. Creating and maintaining the physical map requires careful planning and implementation, as beacons may move, appear and disappear in an unpredictable manner. In addition, Bluetooth beacons also face competition from other wireless technologies, including Wi-Fi and NFC. Bluetooth beacon is new to higher education and enters in the trigger this year with a five- to 10-year plateau. Despite the many use cases for higher education, Gartner expects that education adoption will lag the corporate world.

User Advice: Institutions that can benefit immediately from Bluetooth beacon's microlocation and context-aware capabilities are advised to start engaging technology providers to determine the cost and complexity of such a deployment. Given the differing maturity levels of the various solutions, institutions should look at solutions that implement Apple's iBeacon technology, at a minimum.

- Look for a solution that offers a comprehensive beacon management platform that allows users to quickly deploy and easily manage the beacons. Ideally, this also needs to integrate with the existing back-end systems such as the SIS and LMS.
- Institutions are advised to understand the data privacy and legal issues surrounding proximity applications and start conversations around these issues with campus leaders early.

Business Impact: The Bluetooth beacon technology, with its proximity detection, contextual awareness and low-power capabilities, has the potential to impact education in the areas of information delivery, wayfinding, attendance, student analytics, student engagement and retention, as well as administrative tasks such as asset tracking. Given its broad reach and potential benefits, institution leaders (both business and IT) are advised to monitor the technology's progress and evaluate its potential.

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Aruba Networks; BKON; Cisco; Estimote; Gimbal; Texas Instruments; Zebra

Recommended Reading: "Cool Vendors in Education, 2016"

Robotic Telepresence

Analysis By: Jan-Martin Lowendahl

Definition: Robotic telepresence is video endpoint technology implemented in conjunction with remotely controlled form factors that facilitate remote video presence where fixed endpoint solutions are too static.

Position and Adoption Speed Justification: Robotic telepresence in education is a relatively low-tech, stand-alone solution that can be used to bring remote participants into classrooms and other learning environments in ways that are engaging and do not require great change on the instructor's part. There are usually two versions: one free-moving and the other desk-based.

These devices do not need any special technical setup; rather, they need only Wi-Fi and a power outlet for the charging station. Robotic telepresence does not need a special classroom and, most importantly, it does not require the professor to change the lecture. It is as close to plug-and-play as you can get with technology, and yet it brings very tangible benefits. With a telepresence robot, a remote learner can take part in on-campus, face-to-face classes with a sense of control that is not available from other types of virtual-presence technology. Early trials indicate that the psychological effect is substantial. When students can be mobile, choose where they are in the classroom and turn to face the classmates they work with, they become much more engaged and get more out of the learning experience. Similarly, the professor in the classroom starts treating the remote learners much more like equals who are participating in the class. However, the key benefit is probably the ready faculty acceptance, which is largely built on the fact that instructors do not have to change their ways. Thus, this represents no extra burden in adapting style or material to a technology that has a learning curve.

This type of telepresence works well with existing campus pedagogical setups. However, one of the more successful setups is for working professionals — for example, nurses, who "teleport" into a nursing lab setting, as they do at Duke University School of Nursing.

One use case for robotic telepresence will always be special due to the profound impact it can have on a person's life. Kids who have been homebound for various reasons — such as immune deficiency diseases or special needs — can suddenly participate in class on a much more equal footing than was previously possible.

While the underlying endpoint technology in robotic telepresence is not new, it is now more "consumerized," it can be implemented in more flexible forms, it is optimized in software and it takes better advantage of wireless networks. Altogether, robotic telepresence enters the Education Hype Cycle between the trigger and the peak, and we expect it to have a relatively quick ride of five years rather than 10 years to the Plateau of Productivity.

User Advice: If you have off-campus students or students with special needs, then invest in pilots of this kind of technology now. This is a truly low-hanging fruit that brings immediate value, and requires very little interoperability efforts and changes in existing pedagogy.

Evaluate whether you can take the next step and use this technology for personalized lecture capture — for example, making a Double robot follow the professor, capturing a lecture from the student's point of view. Also see personalized lecture-type technology (for example, Swivl), because robotic telepresence and personalized lecture capture are expected to merge.

The heavy social, mobile and cloud aspects of these technologies also mean that CIOs must ensure that the wireless, security, and privacy policies and infrastructures at their organizations and institutions are able to support the widespread use of these types of tools and technologies.

Emerging challenges include how to manage fleets of telepresence robots as they become more prolific. This includes issues such as where to station the robots on campus for easy access and charging, yet preventing theft of the iPads that are often components of these products, as well as the increasing demand on Wi-Fi that comes with even more video communication. Other potential challenges, especially in the U.S., include safety and liability, as well as how to avoid accidents — especially in environments with small children. These issues are interesting as more types of robots mix with humans, and we expect policies and procedures to evolve as we gain experience.

Business Impact: There is an increasing blurring of boundaries between on-campus and online education to enable true anywhere, anytime and any-pace education. Robotic telepresence represents a new physical dimension to remote participation that is appealing to deeply rooted human traits.

For institutions with remote learners, and even for those that want to offer an alternative to students with prolonged health issues or special needs, robotic telepresence provides an obvious addition to the toolkit of any director of teaching and learning technology, and for any education-focused CIO. It is rare when such low-hanging fruit is offered by a single technology at a relatively low price point. Overall enterprise adoption is still nascent, but the ROI for most use cases is high in many industries, often displacing not only travel but also the need for a full-time head count at a remote site. These general use cases vouch for a large market that will sustain many vendors and drive improvement of features and lowering of cost. First-mover advantage will be most evident in specific industries such as healthcare, technology and education.

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: Double Robotics; Revolve Robotics; Suitable Technologies; VGo Communications

Recommended Reading: "Top 10 Business Trends and Strategic Technologies Impacting Higher Education in 2016"

"Cool Vendors in Education, 2016"

Exostructure Strategy

Analysis By: Jan-Martin Lowendahl

Definition: Exostructure strategy refers to acquiring the critical capability of interoperability to leverage the increasing numbers of partnerships, tools and services in the education ecosystem.

Position and Adoption Speed Justification: The exostructure concept is about building an "exoskeleton" of services that supports the education institution from the outside rather than the inside. The building blocks are standards such as eduPerson and the Caliper Analytics standard, which allow a freer flow of information among education ecosystem players. When done right, the exostructure approach enables institutions to leverage industry (and other) best-practice services from the cloud, rather than having to bring them inside the campus walls. The exostructure approach also enables a much more flexible and agile IT services approach. In a competitive world, the winner in the long run is not the strongest, but rather the most adaptable.

The key enablers of exostructure strategy in education are standards such as Learning Tools Interoperability (LTI), Caliper Analytics standard Question and Test Interoperability (QTI), Accessible Portable Item Protocol (APIP), eduPerson, Metadata for Learning Opportunities (MLO), Open Badge Standard and Postsecondary Electronic Standards Council (PESC) transcripts. Recent years have seen increased interest in these types of standards and organizations, such as PESC and the IMS Global Learning Consortium, respectively. Many vendors now understand that these standards are good for their customers and that interoperability increases their potential market. For example, all major learning management system (LMS) providers now support LTI, and several vendors are interested in the work around the Caliper Analytics standard, which promotes the idea of personalized learning. Furthermore, the education community facilitates the uptake of exostructure services through trusted brokers, such as InCommon and the Internet2 Net+ Initiative.

This exostructure strategy profile is Gartner's attempt to track institutions' ability to interoperate in and leverage the education ecosystem. It is not about following a specific technology standard or vendor offering — although the two are prerequisites for the successful execution of an exostructure strategy.

As a concept, exostructure strategy is not new, but it is gaining traction in the education ecosystem. Several new vendors (such as N2N, Compro Technologies and DecisionDesk) represent increasing uptake and options. Altogether, exostructure strategy makes a relative leap, but is still in the Innovation Trigger phase, with a five- to 10-year trajectory to the Plateau of Productivity.

User Advice: Exostructure strategy is about achieving a substantially higher level of interoperability, which is necessary to leverage the full potential of the education ecosystem. It is also about creating an institutional "interoperability first" mindset through a new language that enables the education CIO to tell a compelling story that drives change.

Parts of the compelling story:

- Overarching is the imperative for collaboration in many parts of higher education, and how exostructure enables such collaboration.

- A strategy to find, attract and keep skilled IT staff members with a critical mass of skill by using exostructure standards, or by using exostructure services to leverage the available scarce skills.
- Cost optimization by using just the right service at the right time, balanced against bandwidth and storage costs.

Parts of potential issues:

- The need to handle thorny data privacy and storage issues in many parts of the world.
- Getting over a culture of "not invented here" in many parts of higher education in order to focus on quickly delivering value to end users, rather than building the perfect homegrown solution.

At a practical level, the education CIO should execute the exostructure strategy through identifier, format and protocol (IFaP) portfolios of standards, but beware of vendors with a strategy of proprietary or "walled garden" standards.

Education CIOs and institution leadership should use an exostructure strategy to focus on leveraging "each other's strengths" in the education ecosystem, and begin by using trusted cloud brokers.

Internally, education CIOs can prepare by focusing on the capability to change through defining services, and they should use service portfolios and service catalog tools for exostructure agility.

Business Impact: "Interoperability" fundamentally means an ability to leverage other education ecosystem players' strengths, while the institution focuses on its competitive differentiators. The key institutional capability is change, and the concrete strategy is to build in an exostructure, rather than on an infrastructure. The future belongs to exostructure, not infrastructure.

Digitization of analog processes and assets is feeding the expansion of the education ecosystem, thereby increasing competition, while digitalization is changing the nature of the competition, as outlined in "The Gartner Higher Education Business Model Scenarios: Digitalization Drives Disruptive Innovation and Changes the Balance." While this networked world represents new threats, it also creates new opportunities. The same forces that put competition on campus (such as the internet "death of distance") are also the key to increased competitiveness. The key to success is a new, substantially higher level of interoperability.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Recommended Reading: "Gaining Competitive Advantage in the Education Ecosystem Requires Going Beyond Mere Infrastructure to Exostructure"

"The Gartner Higher Education Business Model Scenarios: Digitalization Drives Disruptive Innovation and Changes the Balance"

MOOC Platforms

Analysis By: Glenda Morgan; Jan-Martin Lowendahl

Definition: Massive open online course (MOOC) platforms are the technology underlying the ability to support learning at scale in both open and nonopen formats.

Position and Adoption Speed Justification: MOOCs created a very large amount of hype based on their promise to change higher education by bringing scalability and openness on a large scale. Many predicted that MOOCs would become dominant in higher education, replacing some, if not many, established institutions. That did not come to pass, but many users began to experiment with MOOC-enabling technologies as a way of trying out massive and/or open approaches to teaching. These technologies are increasingly being consolidated into discrete platforms that are being used to offer MOOCs in a range of settings, thus the change in terminology from enabling technologies to platforms. MOOC platforms are generating some hype, experimentation and promise as educators and corporations explore ways to leverage very large numbers of learners or students in courses or open courses to experiment with new pedagogical approaches, such as social learning and peer grading. In addition, a key goal is to increase outreach, establish brand identity and improve digital skills.

The hype around MOOC platforms is growing, which we see reflected in the growth in the number and varieties of platforms, but most uses of these technologies are still at the experimental stages, thus justifying their position in the Innovation Trigger phase. The time to plateau is likely to be at least five to 10 years, as higher education institutions, corporations and public organizations around the world grapple with how to position massive or open learning as part of their overall digitalized learning strategies. Some platforms, such as Open edX, have improved substantially over the past two years and are attracting attention as a result, but most platforms are still fairly rudimentary and limit massive and open pedagogy as a result.

User Advice: CIOs should explore MOOC platforms as a way of advancing the goals in their institutions' general or IT strategic plans. Three goals that are likely to benefit most from the use of MOOC platforms are increasing student engagement, outreach and access. Given the innovative and early state of many platforms, it would be advisable to run pilots, rather than invest outright. Some platforms are run entirely by third parties, and CIOs should carefully consider the risks and benefits of working with external vendors where they have no ability to brand or control the offering. CIOs should, therefore, think about what options they have, as well as exit strategies, preservation of data and what fallback options they might have if a company changes course or ceases to exist.

Business Impact: MOOC platforms have the potential to have a big impact on student learning, as well as on the scalability of both education and outreach. A lot will depend on the ability of CIOs to develop policies around the appropriate use of the platforms. The platforms will need to mature significantly, and cloud solutions will need to become more widely available.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Instructure; Open edX; Wemooc

Classroom 3D Printing

Analysis By: Kelly J. Calhoun; Jan-Martin Lowendahl; Pete Basiliere

Definition: Classroom 3D printing is the practice of using a device to fabricate physical objects from digital models for the purpose of creating teaching aids, demonstrating a concept or enabling students to create models.

Position and Adoption Speed Justification: 3D printing has practical and pedagogical benefits that make it a good tool to use in education and research. In academic research, 3D printing was used early on to do prototyping of, for example, machine parts, and for modeling complex chemical structures, such as enzymes, for visualization purposes. Some of that use trickled down into undergraduate and graduate education, but only to a limited extent due to cost and complexity of running a 3D printer.

As 3D printer cost and complexity continue to come down, professors and teachers are building on previous experience and seeing opportunities to use this tool on a larger scale in art, design and engineering programs, and to a lesser degree, in some career and technology high school programs.

The significant increase in interest in makerspaces and constructivist learning has increased the number of elementary-level schools exploring applications for 3D printing, especially in teaching the STEM disciplines. We are far from having a 3D printer in every classroom, even in technical universities. That said, initiatives such as Taiwan-based XYZprinting's plan to place a 3D printer in every elementary school in China will likely add use cases and research examining its effectiveness in this context. The increasing availability of low-cost and easy-to-use consumer 3D printers now puts this tool within the reach of K-12 teachers through vendors such as 3D Systems, MakerBot (a unit of Stratasys) and XYZprinting.

Classroom 3D printing is for enthusiastic teachers who have a drive to try it out. However, the technology will not necessarily change the curriculum. Indeed, there are many educational technology tools of far broader use and potential, such as the flipped classroom model, gamification and learning analytics, that have yet to fully penetrate classrooms and curricula.

Classroom 3D printing continues to advance through the trigger phase, although the technology itself is more mature than this position indicates. We also anticipate more than 10 years to the Plateau of Productivity, taking into account a global view of the market and the slow rate of change within the education community.

User Advice: The instructional uses for 3D printing make it a technology well worth evaluating. Education CIOs and educators responsible for pedagogical development must collaborate and consider making 3D printing available on a classroom or campus basis, either through buying consumer-grade 3D printers or acting as a broker for 3D-printing on-demand services. A key role for education CIOs is to evaluate the consumer 3D printer ecosystem — that is, software, materials and printer — and gauge when it is ready for mainstream use. Another key role is to develop the robust

infrastructure necessary to support campuswide collaboration among faculty, researchers, and students while ensuring security and copyright protections.

Business Impact: Classroom 3D printing technology has transitioned from one that is prohibitively expensive for all but research organizations to one that has pricing that makes classroom use possible. The hype in the general press has heightened consumer — and student — awareness of the technology and has resulted in early adopters' use in their classrooms.

Classroom 3D printing complements and extends many curricula. However, it is in competition with so many other pressing needs that it is not yet poised for major uptake globally.

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: 3D Systems; MakerBot; Stratasys; Thinker Thing; XYZprinting

Recommended Reading: "Cool Vendors in 3D Printing, 2015"

Affective Computing

Analysis By: Jan-Martin Lowendahl

Definition: Affective computing technologies sense the emotional state of a user (via sensors, microphone, cameras and/or software logic) and respond by performing specific, predefined product and service features, such as simply changing a quiz or even recommending a set of physical activities to fit the mood of the learner.

Position and Adoption Speed Justification: True affective computing technology, with multiple sensor input, is still mainly at the proof-of-concept stage in education. However, it is gaining more interest as online learning expands and seeks the means to scale with retained or increased quality. A major hindrance in its uptake is the lack of consumerization of the needed hardware and software involved. It has to be inexpensively available for students, through the use of personal devices, for example. Products such as Affectiva's Affdex are promising because they enable relatively low-cost, packaged access to affective computing. Original use cases were for testing media and advertising impact on consumers.

Recently, Affectiva announced a patent "Using Affect Within a Gaming Context," which was implemented in the game Nevermind enabling players to experience emotion-based feedback on a minimum-specification Windows or Macintosh machine with almost any standard webcam. This is something very close to adaptive learning and could represent a breakthrough for affective computing for the masses. Affectiva markets its technology as "emotion AI," using deep learning capabilities on an emotion data repository of nearly 4 million faces analyzed from 75 countries, amounting to more than 50 billion emotion data points. This relates affective computing to the recent advances in smart machines.

Lenovo has released AirClass, a new distance education platform that has webcam-based emotion detection and emotion analytics as one of its features. AirClass is delivered as SaaS, and the subscription pricing is based on the number of instructors and number of classrooms per instructor, starting at $540 a year.

This makes it very accessible and again signals a breakthrough for affective computing in education.

A more specialized branch of affective computing involves "social robots." The Emote project used a commercially available robot called Nao introduced in 2008. Nao's sibling Pepper is designed to recognize the principal human emotions and adapt its behavior to the mood of the interacting human. Both IBM and Microsoft collaborate with SoftBank to enable smart-machine-type capabilities via the cloud. Even though most of the existing applications of Pepper are in commercial store settings, Pepper is now available for sale to private individuals in Japan.

As content (for example, textbooks) becomes more digitized and is consumed on devices that have several additional sensors (for example, tablets with cameras and accelerometers), interesting opportunities will arise to mash up the capabilities of, for example, an open adaptive learning platform, such as Cerego or CogBooks, and affective software such as Affectiva's Affdex, making affective computing for untutored learning more accessible. All this combined with several quantified-self-type sensors such as Fitbit trackers will increase the number of data points available for statistically based and eventually smart-machine-based adaptive learning. We now see many of these capabilities converging in many form factors, ranging from inexpensive webcam-based affective computing to robotic platforms increasingly supported by quickly developing cloud-based smart machine ecosystems.

Altogether, this merits a jump to just before the Peak of Inflated Expectations as we wait for increasing hype specifically in education, with five to 10 years until it reaches the Plateau of Productivity.

User Advice: Now is the time to start experimenting with affective computing solutions such as AirClass and Pepper to be prepared for the strategic tipping point of implementation. CIOs, together with academic leaders, should start estimating the potential impact in terms of possible pedagogical gains and financial impact, such as increased retention for online learning. Institutions with a large online presence, or that want to exploit the hype for brand recognition, should start piloting now. CIOs should partner with retail companies, consumer electronics companies and universities (particularly online universities) to further explore this field.

Affective computing can involve collecting sensitive data about students, which makes it important to make sure that any privacy laws and concerns of the users are met. Any use of affective computing should involve an opt-in process.

Business Impact: One important advantage of this technology is that, even if it is inferior to a face-to-face student-teacher interaction, it scales well beyond the physical lectures with over 100 students that today offer limited individual pedagogical adaptivity anyway. A potential complement or competitor to remedy the scalability problem is the social-media-based peer-mentoring

approach, as exemplified by Rosetta Stone (formerly Livemocha) as well as by massive open online courses (MOOCs).

In general, affective computing is part of a larger set of approaches to further personalize the educational experience online. Another example is adaptive learning that depends on the statistical data of learners in the same pedagogical situation. It is also related to context-aware computing in general.

The ultimate aim of affective computing in education is to personalize and enhance the learning experience of the student, which should result in tangible results like higher grades, faster throughput and higher retention.

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: Affectiva; Affective Media; IBM; Pearson

Recommended Reading: "Business Model Innovation Examples in Education"

At the Peak

Digital Assessment

Analysis By: Kelly J. Calhoun; Glenda Morgan

Definition: Digital assessment refers to the application of digital technologies to create, administer, report and manage tests and examinations.

Position and Adoption Speed Justification: The means of reliably understanding and evaluating what someone has learned have been the dream of educators for centuries. The trend toward highly standardized, high-stakes accountability in K-12 has created a multibillion-dollar industry around summative, high-stakes assessments. Higher education institutions are under increasing pressure to assess students in a scalable, "any place, any time" manner, as well as to show evidence of student learning.

However, the "digitization" of the same old assessments is not what finds this topic closing in on the Peak of Inflated Expectations. The traditional assessments of the past may lend themselves nicely to quickly quantifiable means of judging educational institutions, but significant questions are arising around whether they actually measure data relevant to understanding what students could or should be learning, given the shift in direction of several education trends in both K-12 and higher education.

Several other new technologies on the rise add another dimension to understanding where digital assessment is heading. The collection of massive amounts of data is needed for deeper learning analytics and adaptive learning platforms. Formative assessment using technology is surging in

popularity in support of this data capture, allowing educators and students to receive immediate and continuous feedback throughout the learning process. Cognitive systems, joining natural-language processing and machine learning, are creating a whole new world of what we can learn about students and how we can adapt learning environments to meet their needs and learning preferences in new ways.

With the growth of online learning and growing concerns about integrity, especially in assessments taken by students at a distance, the integrity of the results is key. There has been a growth of technologies that offer ways to verify the identities of students taking the assessments, as well as to ensure that cheating does not occur (or that if it does, it is discovered).

Today's assessment platforms are increasingly cloud-based (at times, SaaS-delivery models), relying on interoperability standards such as IMS Global's Question and Test Interoperability (QTI) to standardize the format of assessment content and results, and allowing for the use of multiple systems simultaneously. Open-source solutions are giving organizations significant flexibility for either buying or developing the content needed. Besides traditional dedicated assessment platforms, educators demand digital assessments be included in digital learning resources purchased (so they remain aligned), and may leverage assessment tools in the learning management system as well. This is creating an increased need for strategies to manage all this diverse learning data effectively.

Altogether, given the complexity of the field and the early phase of development of many of these technologies, we believe that a position in the Technology Trigger phase of the Hype Cycle is warranted. It is not yet fully at the Peak of Inflated Expectations, but likely will be within the next year or two. However, we anticipate it will still take as many as 10 years for digital assessment technologies to reach the Plateau of Productivity.

User Advice: Many education organizations are adding digital assessment to their list of topics requiring more attention and strategic planning this year. Complex questions are arising around what kinds of platforms lend themselves to the design, development, banking, delivery and analysis of items for performance. Interoperability has moved into a critical position, as have options for analytics and reporting.

The broader questions around how to develop a strategy for both new means of formative assessment and for how to manage high-stakes summative assessment data will be changing over the next couple of years. Challenges also remain in a significant number of organizations (particularly in K-12), where access to devices needed to quickly and universally perform digital assessments as and where needed is not necessarily a given. CIOs may wish to clearly establish use cases for their assessment needs so they can identify the solution or mix of products needed. CIOs should also pay close attention to security, privacy, and how to store and manage the data from these tools, as well as the policies needed for these products to be used effectively.

Business Impact: Digital assessment holds the promise of making significant improvements in how we understand, manage and improve learning. New platforms for the development and management of assessments are also a key component for online learning reaching full maturity and for the scalability of education.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Computerized Assessments and Learning; CoreSpring; Educational Testing Service; Examity; ExamSoft; McGraw-Hill Education; Respondus; Taskstream

Recommended Reading: "Five Key Digital Assessment Trends in U.S. K-12 Education"

"Analytics, Assessment and Adaptive Learning Will Prepare You for the Algorithmic Education Evolution"

"Top Five Strategic Technologies Impacting K-12 Education in 2016"

"Predicts 2016: Building the Foundation for the Digitalization of Education"

"Top 10 Strategic Technologies Impacting Higher Education in 2016"

"Cool Vendors in Education, 2016"

SaaS SIS

Analysis By: Terri-Lynn B. Thayer; Kelly J. Calhoun

Definition: Software as a service (SaaS) for student information systems (SISs) in education is software that is owned, delivered and managed remotely by one or more providers, based on a single set of common code and consumed in a one-to-many model by all contracted customers at any time, on a pay-for-use basis or as a subscription.

Position and Adoption Speed Justification: SISs provide administrator-, faculty- and student-facing functionality to manage key institutional information assets such as demographic data, course offerings, grades and transcripts.

SaaS is still a relatively new delivery model for the education market. Over the past few years, early higher education adopters implemented SaaS applications for HR and finance. As the number of institutions with successful deployments and advancing implementations for these domains has grown, so has the interest in an equivalent option for SaaS-based SIS. Several vendors are in varied stages of SaaS SIS development in higher education (for example, Jenzabar, Oracle, Unit4, Workday) and in K-12 (for example, Infinite Campus, Skyward, SunGard, Edupoint).

Many academic institutions with on-premises SIS modules are finding themselves increasingly weighed down and constricted by the demands of maintaining on-premises solutions. Facing major upgrades or contract renewals, they are assessing whether a SaaS model can offer a more predictable total cost of ownership (TCO), while affording more agility and innovation to meet changing business demands. The SaaS model typically requires adoption of standard business practices (implement by configuration, not customization, of the software) but, in return, provides new capabilities more frequently, at least several times per year. Finally, SaaS solutions may offer an

improved user experience based on a more modern architecture, in-memory technology, and native mobile, social and CRM functionalities, which gives them an edge over traditional providers in the minds of many SIS users.

SaaS SISs have been successfully adopted in K-12 and a limited number of higher education institutions — often small or for-profit institutions. However, SaaS point solutions in higher education, such as financial aid, have been successful in a broader set of institutions. Vendors providing e-SaaS options for K-12 and large, complex and global higher education institutions are generating significant hype. These offerings are beginning to emerge either as individual modules or complete integrated solutions. We expect the benefit for implementing this technology to be high, given the potential for supporting new business models and dramatically improving the user experience — thereby promoting student engagement and faculty productivity. SaaS SIS has entered the peak this year and as additional components become generally available over the next few years, we expect the speed of adoption to be moderately fast over the next five plus years.

User Advice: Because SaaS SIS solutions are usually based on a subscription licensing model, they often are an operating expense, rather than a capital expenditure. Thus, the upfront cost is less for a SaaS solution, but the ongoing TCO may not be. Although cost is only one consideration, perform a cost analysis.

While new cloud models have improved architectures to support configuration, the commitment to a customization-free implementation will require strong leadership and governance structures to achieve success. Ensure academic leaders are willing and able to sponsor the initiative and specifically lead the charge for the inevitable change of faculty practices and processes.

Institutions with aged on-premises SIS implementations should begin planning now to determine if, when and how SaaS SIS will fit into their future.

Business Impact: SaaS SISs have the potential for high business impact. Their modern design clearly can bolster operational efficiencies and effectiveness, while improved user interfaces will surely increase student and faculty engagement. However, the most important impact is likely to be the support of new business models essential for the modern institution, such as support for nontraditional students, a competency-based curriculum and financial aid.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Edupoint; Jenzabar; Oracle; Skyward (PaC Student Management System); SunGard; Unit4; Workday

Recommended Reading: "Market Guide for Higher Education Student Information Systems"

"How Changes in the K-12 SIS Ecosystem Will Impact Your Planning in 2015"

"Market Guide for K-12 Student Information Systems, U.S."

Competency-Based Education Platforms

Analysis By: Glenda Morgan; Jan-Martin Lowendahl

Definition: Competency-based education (CBE) is a way of organizing instruction based on the learner's acquisition or possession of specified competencies. CBE platforms are niche tools to support the new mode of instruction, with more flexible systems that allow students to advance through courses at their own pace, and with enhanced assessment functions to build and test the competencies.

Position and Adoption Speed Justification: CBE and the platforms to support it are receiving a lot of attention, primarily in the U.S. The main driver for the interest in CBE is a concern with decreasing students' time to earning a degree and increasing their mastery of the subject matter. Usually, CBE was associated with nontraditional students at institutions such as Southern New Hampshire University (SNHU), but now many institutions have started to adopt CBE and CBE platforms in order to support a wider range of students.

There are two types of CBE: (1) direct assessment, where the learner demonstrates competencies that have been previously acquired; and (2) competency by credit, where students work through course materials organized around a set of specified competencies at a speed that they set themselves. Traditional courses and programs have a set period of time for completion, but the amount learned is variable; however, competency-based learning keeps the amount learned (the competencies) fixed, but the time the student takes to complete it can vary.

Traditional learning platforms rely on grades, seat time and students moving through a course at the same pace as a cohort. Because of this, traditional platforms are not well-suited to support CBE. Additionally, CBE platforms provide the following features:

- A tool to help instructors specify competencies that are linked together in a framework
- A wide variety of learning activities to facilitate and enable self-paced learning
- A rich assessment environment in which to test student knowledge against specified competencies
- A way of dealing with time in a more flexible way, such that each student can work through and complete the course at his or her own speed

Over the past two years, we have seen the release of several specialized CBE platforms to support the more than 350 institutions that have announced their intention to launch CBE programs. Sample vendors include LoudCloud's Fastrak platform, Ellucian's Brainstorm, Motivis Learning and the Flat World CBE learning management system (LMS). Traditional LMS vendors (such as D2L) now include a competency-based engine, and Blackboard and Moodle have announced plans or are unveiling their own solutions.

Over the past year, the interest in CBE and CBE platforms has increased dramatically. This merits a position up the Peak of Inflated Expectations. Hype about CBE and the platforms needed to

support it will continue to grow; however, many institutions will find that they have not fully thought through the implications of offering CBE, as well as the costs and support demands of running two learning platforms. We believe that, in the best case, there will be another five to 10 years to the Plateau of Productivity and mainstream adoption.

User Advice: CIOs should determine the extent and maturity of their institutions' interest in CBE, and how much demand there will be for a specialized CBE platform. CIOs should also explore the extent to which their current learning platforms (such as D2L, Canvas, Moodle and Blackboard) either have competency-based learning capabilities or can be modified to accommodate CBE activities. If colleges and universities are in the process of launching an RFP for a new learning platform, then CBE needs should certainly be considered. Using a CBE platform also has major implications for the student information system, as well as for financial aid eligibility and tracking. CIOs should be aware of these implications and bear both in mind when choosing a new system.

Business Impact: The potential business impact is large. Competency-based learning has the ability to increase the scalability of learning while enhancing the personalization. Additionally, with CBE there is the promise of increasing student learning — because the platforms test against mastery in a subject, rather than simply passing a threshold set between a C and a D grade. So, as students move to the next stage or module, they have mastered the knowledge they need in order to succeed at the next level. The self-paced nature of CBE platforms allows students to work through course work as quickly as they can; thus, these platforms hold the promise for quickening the time to degree for at least some students.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Sample Vendors: D2L (Brightspace); Ellucian (Brainstorm); Flat World; LoudCloud (Fastrak); Motivis Learning

Recommended Reading: "Ellucian's Helix LMS Purchase Adds New Wrinkle to Higher Ed Markets"

Learning Analytics

Analysis By: Glenda Morgan; Terri-Lynn B. Thayer

Definition: Learning analytics is the collection and analysis of data about learners, and their instructional and learning contexts, with the goal of improving learning and learning environments.

Position and Adoption Speed Justification: Learning analytics is high on the priority list for many institutions in higher education who are under increasing pressure to improve student outcomes and to show evidence of learning. On the demand side, the drivers are the growing push for accountability for higher education systems that are increasingly costly for students to attend and where outcomes such as retention, time to degree and demonstrated learning gains are at less than optimal levels for the vast majority of universities. On the supply side, the interest in learning

analytics is being fueled by the development of a number of technology solutions and investment in these solutions.

Learning analytics technologies typically take one of three forms: early-alert warning or reminder systems, predictive analytics platforms, and course planning and navigation systems. These systems typically pull data from the student information system (SIS) and learning management system (as well as other systems) to identify students at risk or points of failure in the system. Course or degree navigation systems can suggest better paths through course work for students. At their heart, learning analytics products use data to identify problems or risk factors at the level of the individual on the basis of which universities and colleges need to stage interventions. There is considerable overlap between learning analytics technologies and institutional analytics technologies though in the latter there is more emphasis on using data to improve operational efficiencies and outcomes.

The hype around learning analytics is growing but it is likely to get more intense as the pressures to adopt these technologies grow. But most institutions are still in the very early stages of adoption. These factors mean that they are part of the way up the slope toward the peak. The time to plateau is likely to be two to five years but will likely be much closer to five years than to two. Factors driving the adoption of learning analytics technologies are pressures on higher education institutions to improve student success and learning and high levels of investment and innovation in the space.

User Advice: CIOs should make sure that they are clear on what are the major issues they are hoping to address. Having some clarity about these issues will help them in choosing the right mix of solutions. Successful implementation of learning analytics projects requires collaboration from multiple parts of the institution so CIOs should be advised to bring these stakeholders together to decide on which technologies should be deployed in what way. CIOs should work to identify where relevant data is held on campus and that it is accessible and reliable. Additionally, CIOs should monitor the ongoing development of the Caliper standard from IMS Global, which will greatly facilitate interoperability between learning analytics applications and other technologies.

Business Impact: Learning analytics technologies when used effectively have the potential to help identify problems in student learning paths at the level of the individual, the course, the program or the institution. As long as appropriate interventions are then made to address those problems, the impact could be transformational in that we could see great improvements in student learning outcomes.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Blackboard; Civitas Learning; Conexus; D2L; Education Advisory Board; Hobsons

Recommended Reading: "The Coming of Age for CRM in Higher Education"

"Top 10 Business Trends Impacting Education in 2015"

"Top 10 Strategic Technologies Impacting Education in 2015"

"Cool Vendors in Leveraging Data in Education, 2015"

SIS International Data Interoperability Standards

Analysis By: Jan-Martin Lowendahl; Terri-Lynn B. Thayer

Definition: Student information system (SIS) international data interoperability standards are the data formats needed to facilitate and even automate global student mobility.

Position and Adoption Speed Justification: An increasingly global workforce ecosystem supported by increasing international student mobility is now driving the interest in SIS international data interoperability standards, or at least more standardized transcripts that enable machine-to-machine interaction. What started as a political idea to increase mobility in the European workforce through the Bologna Process and a focus on the costs associated with processing international applications has become a truly global concern. Earlier work, such as the eduCourse schema and Metadata for Learning Opportunities as well as mobility projects (such as "Emrex" and "Erasmus Without Paper") supported by the Rome Student Systems and Standards Group (RS3G) and the EU have now been reinforced by organizations such as IMS Global Learning Consortium and PESC efforts, building on the Open Badge momentum which has a truly global reach. This technical progress is supported by an equally important political progress as the Groningen Declaration continues to grow its support. Several macroforces, such as unemployment pressures at the same time as many employers are challenged to find talent, are both powerful drivers that vouch for continued efforts and even endurance in solving the problem. This, in combination with technical solutions such as open badges and blockchain, finally promises to move the needle beyond hype in this issue. As SIS vendors start to incorporate functionality to handle badges and modern e-transcripts, there will be real experience beyond the prototypes developed by RS3G.

Even if these activities are still at too early a stage to establish true automatized international interoperability, the change in gear toward technologies with broader appeal make SIS international data interoperability standards climb just past the top of the Peak of Inflated Expectations this year, demonstrating the increasing political will to solve this important issue. But from a practical point of view, the many complexities in this issue make clear that it will take at least five to 10 years to the Plateau of Productivity, even if we are beginning to discern a technical roadmap.

User Advice: Institutions that expect to recruit extensively from abroad must monitor developments closely to be ready to adopt as soon as possible. They should work through their vendors or consortiums to establish a roadmap for adoption. The window during which this can be a competitive advantage is likely to be relatively small, and institutions should anticipate that not having the capability of a streamlined application process enabled by SIS standards can quickly turn into a competitive disadvantage. However, when considering this capability, it should be noted that standards usually take longer than technologies to mature and be accepted on the Hype Cycle. SIS international data interoperability standards should be part of the institution's exostructure strategy. CIOs should carefully evaluate vendor's abilities and commitments to these standards initiatives as key differentiators to inform product selection and retention.

Business Impact: SIS international data interoperability standards have a direct impact on the ability to recruit the right students to the right courses, as well as on costs for handling applications. The visibility and scrutiny and improved match of institutional course offerings to students will increase with price/performance comparison engines that will likely develop, such as PriceRunner, and it will be important to master the factors that lead to applications from the "right" student profiles. In particular, interoperability of student data will enable a higher degree of process optimization, driving down cost in administrating and risk in accepting students' applications. Standardization at this level will also facilitate economies of scale of administration through shared services, which will benefit the national or state education system. These standards will also enable more efficient integration of systems within an institution, for example, LMS to SIS. In addition, standardization will facilitate big data projects that, because of SIS international data interoperability standards, will have to spend far less time on data normalization and data cleansing. Experience from big data projects could also be fed back into the SIS standards to improve the predictability of big data. But above all, there is a benefit to the larger "skills ecosystem" that needs more efficient matching between skills and jobs for the global economy to grow.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Recommended Reading: "Findings: Bologna Process Demands True International Student and Course Data Standards in Higher Education Throughout the EU"

"Gaining Competitive Advantage in the Education Ecosystem Requires Going Beyond Mere Infrastructure to Exostructure"

"Top 10 Business Trends and Strategic Technologies Impacting Higher Education in 2016"

"Reinventing Education Credentials Using Blockchain as a Possible Missing Link for the Open Badge Infrastructure"

Institutional Analytics

Analysis By: Terri-Lynn B. Thayer; Glenda Morgan

Definition: Institutional analytics is the collection and analysis of data about the institution that yields actionable insight with the goal of improving services and business practices, as well as finding new efficiencies, cost savings or revenue streams.

Position and Adoption Speed Justification: Institutional analytics is high on the priority list for many institutions in higher education that are under increasing pressure to improve student recruitment, enrollment, retention and alumni giving, as well as identify institutional efficiencies and effective use of resources. As the demand for analytics increases, so has the supply of vended solutions, some of which include not just technologies, but also services.

There is considerable overlap between learning analytics technologies and institutional analytics technologies, though the latter places greater emphasis on using data to improve operational efficiencies and outcomes. Another area of overlap is with student retention CRM systems, though in CRM systems there is more emphasis on managing the process of intervention.

Today many institutions have business intelligence platforms and data warehouse technologies from megavendors such as IBM, Microsoft and Oracle, or from their ERP provider, such as Ellucian and Jenzabar. Most have used these tools to provide operational reports describing what has happened in the past. Now a new breed of analytics offerings that is marketed as capable of predictive and even prescriptive analytics is becoming available. These tools are often purpose-built, addressing key issues for higher education such as recruitment and retention. Some of these offerings combine services with the tools and even benchmarking with other institutions as additional benefits. While these offers are enticing, they are in their early days and most have not yet established a track record of proven results. Gartner observes that institutions are now investing in multiple analytics technologies.

The hype around institutional analytics has peaked, but it is doing so at a time when CIOs report some formidable barriers such as lack of skilled staff, faculty resistance to data-driven decisions and a lack of affordability of analytics initiatives. As pressure for results mounts, it is likely that institutional analytics will barrel quite quickly toward the Trough of Disillusionment. However, Gartner expects that its movement to the plateau will also be reasonably fast — in a two-to-five-year time frame. This movement will be propelled by the high perceived benefits and the rapid innovation by vendors in this space, which are likely to make it easier to achieve results with fewer skilled staff.

User Advice: Identify the problems to be solved by analytics and the existing datasets that can be brought to bear on them, because much of the data that is required to solve specific problems may already exist. Leverage technologies and analytics tools the institution already owns before investing in new ones. Start small and build — thus growing institutional analytics maturity in a measured and sustainable way.

Business Impact: Institutional analytics technologies, when used effectively, have the potential to help improve recruiting, enrollment, retention, alumni giving, and the efficient and effective use of resources at the institution. However, these benefits will only be realized if the institution is ready, willing and able to make decisions and take actions based on the insights revealed by the analytics tools.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Ad Astra Information Systems; Blackboard; Ellucian; Hobsons; IBM; Microsoft; Oracle; Phytorion; Rapid Insight; Tableau Software

Recommended Reading: "Assessing the State of Institutional Analytics in Higher Education"

"Three Important Ways the Analytics Landscape is Changing in Higher Education"

"Top 10 Business Trends Impacting Higher Education in 2016"

DevOps

Analysis By: George Spafford; Thomas E. Murphy

Definition: DevOps is a perspective that requires cultural change and focuses on rapid IT service delivery through the adoption of agile, lean practices in the context of an integrated approach. DevOps emphasizes people and culture to improve collaboration between development and operations groups as well as other IT stakeholders, such as architecture and information security. DevOps implementations utilize technology (especially automation tools) that can leverage an increasingly programmable and dynamic infrastructure from a life cycle perspective.

Position and Adoption Speed Justification: DevOps doesn't have a concrete set of mandates or standards, or a known framework — like ITIL or Capability Maturity Model Integrated (CMMI) — making it subject to a more liberal interpretation. For many, it is elusive enough to make it difficult to know where to begin and how to measure success. This can accelerate (or potentially inhibit) adoption, and it's key to define what it means to your organization. DevOps is primarily associated with continuous integration and continuous delivery of IT services as a means of optimizing the flow of work across the application life cycle, from development to production. DevOps concepts are becoming more widespread across Mode 2 initiatives, including digital business and the Internet of Things (IoT), and in more traditional enterprise environments; yet every implementation is unique. The creation of DevOps teams brings development and operations staff together to more effectively and efficiently manage an end-to-end view of an application or IT service. To accomplish this and then to continually improve requires major shifts in culture and in how objectives and metrics are set and shared at the team level.

User Advice: DevOps projects are most successful where there is a focus on business value, and there must be executive sponsorship with the understanding that this new team will have to make an often-difficult organizational philosophy shift from traditional development and operations projects today. Focus DevOps projects to develop Mode 2 capabilities to support systems of innovation utilizing agile development.

Recognize that DevOps hype has peaked among tool and service vendors, with the term applied aggressively and claims outrunning demonstrated capabilities. Many tool vendors are adapting their existing portfolios and branding them DevOps to gain attention. Some vendors are acquiring smaller point solutions specifically developed for DevOps to boost their portfolios. IT organizations must establish key criteria that will differentiate DevOps traits (strong toolchain integration, workflow, automation) from traditional management tools. Both development and operations should look to tools to replace custom scripting with improving deployment success through more predictable configurations.

Because DevOps is not prescriptive, it will result in a variety of manifestations, making it more difficult to know whether one is actually "doing" DevOps. However, the lack of a formal process

framework should not prevent IT organizations from developing their own repeatable processes for agility and control.

IT organizations should approach DevOps as a set of guiding principles, not as process dogma. Select a project with both acceptable value and risk involving development and operations teams to determine how to approach DevOps in your enterprise. Start small and deploy DevOps iteratively, taking into account lessons learned along the way. At a minimum, examine activities along the existing developer-to-operations continuum, where the adoption of more-agile communication can improve production outcomes. As development efforts leverage enterprise agile frameworks to scale, DevOps must be addressed as well.

Business Impact: DevOps is focused on accelerating the delivery of business via the adoption of continuous improvement and incremental release principles adopted from agile methodologies. While agility often equates to speed, there is a somewhat paradoxical impact; and smaller, more frequent updates to production can work to improve overall quality, including both stability and control, thus reducing risk. While not explicitly a focus for most DevOps projects, once initial projects are successful, an adjacent but critical outcome is that clients of IT (both internal and external) will have better experiences in application consumption.

Many new and transformational initiatives are not sufficiently focused on reducing risk, but, through iterative use of DevOps and architectural adoption, value can be enhanced while risks and costs can be managed.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Recommended Reading: "Seven Steps to Start Your DevOps Initiative"

"Avoid Failure by Developing a Toolchain That Enables DevOps"

"When Using DevOps Principles, Follow Five Gartner Rules to Minimize Compliance and Audit Findings"

"Survey Analysis: DevOps Adoption Survey Results"

"How to Build a DevOps Release Team"

"Avoid DevOps Disappointment by Setting Expectations and Taking a Product Approach"

Hosted Virtual Desktop Services

Analysis By: DD Mishra; William Maurer

Definition: Hosted virtual desktop (HVD) services combine an outsourcing relationship with HVD technology to deliver fully virtualized and outsourced desktop environments. HVD services provide

users with all the desktop capabilities they require. An HVD provides a user experience by running a desktop image on a virtual machine server, and users access the desktop image remotely via thin client appliances.

Position and Adoption Speed Justification: Gartner sees that digital workplace transformation has fueled the growth of HVD technology, and providers have aggressively started offering this technology, even if uptake/growth has been somewhat more conservative. Many providers have now successfully rolled out the HVD capability in clients, and our End-User Outsourcing Services Magic Quadrant reference survey for 2015 reveals that 42% of customers in Europe and 38% in North America have also implemented HVD services. The cloud-based Microsoft Office and cloud-based business applications are contributing to this growth.

Organizations increasingly tell Gartner that they must integrate HVD service projects with rolling out of mobility solutions. This means, their strategic emphasis has shifted from pure desktop virtualization technology toward application virtualization and corporate application store discussions for multiple end- user appliances, including smartphones.

Various hurdles stand in the way of mainstream adoption of HVD services:

- The current price of HVD services does not meet the expectations of buying organizations, which expect these services to be less expensive by 20% or more than traditionally sourced desktops. HVD services are sometimes priced even higher than traditional desktop services.
- Adding to the cost issue is the problem of licensing complexity.
- HVD services are not a 100% solution, so organizations must support multiple delivery capabilities that can be harder to leverage.
- Depending on the virtualization technology used, bandwidth might be an issue, especially in remote locations.
- Not all workers in an organization will be able to work on HVDs — traveling users, for example, sometimes need to work offline and may require administrator rights on their PCs.

HVD services should be viewed as a new alternative solution for presenting technology offerings to users, rather than as a single specific opportunity or program. HVD services will form an "umbrella" delivery model for a variety of related initiatives to improve the provision of services to users.

HVD services are a great fit for SMBs (with 100 to 249 employees) because they eliminate most of the administration overhead, reducing their need for more IT staff, servers, software administrators and dedicated network connections. As an additional bonus, new users can be enabled quickly — often within minutes if they have access to devices.

User Advice: HVD services are increasingly used as alternatives to, or in conjunction with, traditional desktop outsourcing services. Take a long-term view — do not use them just for short-term cost improvements.

The organizations most suited to HVD services are those that:

- Lack a mature internal desktop and virtualization support function

- Are looking for a high degree of flexibility, such as the ability to move applications around and vary consumption
- Have a strong in-house demand management function
- Have applied, or want to move to, higher levels of standardization
- Favor a centralized service approach for end users
- Aim for greater automation in their desktop environment
- Have many sites (more than 10), each with a small number of end users (five to 50)
- Face cost pressures with current desktop services
- Require a high degree of related desktop security
- Want to consolidate desktop knowledge centrally
- Have standardized business processes, such as accounts payable, accounts receivable, internal service desk, human resources and similar processes, across a large base of end users
- Possess enough insight into end-user profiling to determine use-case scenarios, and specific users that fulfill the conditions for successful use of the technology

Before starting an HVD services project, identify which roles and groups of end users would benefit most from highly standardized environments, and for which HVD services are viable.

Business Impact: HVD services are perceived as flexible, technology-enabled, desktop-as-a-service solutions that are highly standardized and secure. They are attractive to organizations that have decided that efficiencies in commoditized areas such as end-user services are based on the scale, experience and innovation capabilities of sizable service providers. HVD services provide a new way to optimize end-user costs and flexibility. Organizations planning to use them should re-evaluate their approach to, and requirements for, user segmentation, compliance, security and data privacy, because these factors can significantly influence the business case.

HVD services and desktop as a service (DaaS), which are leveraging public cloud services, remain high on the agenda for SMBs because they want to improve business agility and redeploy the resources engaged in desktop support to other areas of IT services. HVDs also bring lower total cost of ownership (TCO) opportunities, which can be an added advantage.

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Adolescent

Sample Vendors: Atos; Capgemini; HCL Technologies; Hewlett Packard Enterprise; IBM; SCC; T-Systems; Tata Consultancy Services; Unisys; Wipro

Recommended Reading: "Forecast: Hosted Virtual Desktop, Worldwide, 2014 Update"

"Desktop as a Service Must Mature in Order to Move VDI Into the Cloud"

"Desktop Virtualization Will Power the Digital Workplace"

"Magic Quadrant for End-User Outsourcing Services, North America"

"Magic Quadrant for End-User Outsourcing Services, Europe"

Sliding Into the Trough

Open Microcredentials

Analysis By: Jan-Martin Lowendahl

Definition: Open microcredentials are about creating ecosystems of open digital "certificates" or "badges" of accomplishments that can be used by an individual to indicate skills learned, no matter the circumstance (for example, in a university or in the workplace). The ideal situation is if a claim represented by an "open credential" is verified by a relevant trusted party and attached to a secure digital identity.

Position and Adoption Speed Justification: Microcredentials in the form of various badges or "points" have existed for some time in digital social environments in general and in learning environments in particular. The phenomenon is closely related to gamification and has won acclaim for its use by education ecosystem players such as Khan Academy. A key problem is that many of these environments are proprietary and closed, which makes it difficult to display achievements outside them.

The aim of open microcredentials is to remedy that problem and to allow anyone to issue credentials that can be portably collected and displayed by an earner, and have a built-in verification mechanism back to the issuers. Creating a truly open and trusted microcredential ecosystem is a challenging task, but we believe that open standards such as the Open Badges standard can make it happen. Many players in the education ecosystem — such as traditional heavyweights Pearson and Educational Testing Service (ETS) and new and innovative players such as edX and Degreed — have committed to adopting the Open Badges standard. In addition, innovative institutions such as University of California, Davis are experimenting with badges for core competencies that have been co-developed with employers. This exemplifies a key feature of the open-badge ecosystem that spans formal and informal education, as well as employer recognition.

A key indicator of traction is that the standards heavyweight organization in higher education IMS Global Learning Consortium has an IMS Digital Credentialing initiative. Increasing interest from important roles such as registrars and their organizations (such as AACRAO) combined with work on eT (extended Transcripts intended for web consumption) show solid interest.

Open microcredentials are still very hot, but as practical use builds experience, so does the list of issues that need to be dealt with. For example, Coastal Carolina University's implementation of Coastal Composition Commons, a universitywide digital badge initiative (using Credly) illustrates well the positive impacts on students' learning and changes in faculty's pedagogical toolsets, but it

also highlights several important issues common to all change. Technology is not the main issue, but communication and convincing people are.

There are many interesting developments such as the combination of standardized (international) e-transcripts, secure distributed ledgers based on blockchain, and an extension of the open badge idea to an ecosystem (including "requirement badges" as well as "attainment badges") that allow for smart machine matching of skills, but these will need to mature.

This merits a position just entering the Trough of Disillusionment where we expect more active testing to take place in the near future. We expect a relatively quick uptake of open microcredentials, with closer to five than 10 years to the Plateau of Productivity. However, that speed could be hampered by issues related to identity management and trust in issuers, as well as by competing ecosystems provided by players that still believe in the old strategy of walled gardens, rather than open ecosystems.

User Advice: For education institutions, issuing open microcredentials is a technology-based capability that will provide more value and motivation to students. It is a low-cost, high-value option to improve student success. If designed properly, it can give the institution more data about its student population. Furthermore, it can build the institution's brand and help market it.

For institutions, it is crucial to set a clear policy about when it is appropriate to issue a microcredential in the name of the institution. The institution should also make sure that the verification mechanism is clear and that the graphical design of the microcredential is aligned with the brand. If possible, the institution should encourage the earner to tie the microcredential to digital identities that are only self-certified.

If the institution plans to accept microcredentials for any kind of application, staff and faculty need to be educated about how to verify microcredentials.

Faculty is a key enabler of a successful implementation of open microcredentials, and any project needs to be led by the academic side of the institution, not by IT. Developing clear use cases that show how open microcredentials complement traditional diplomas and certificates, is a key to win the hearts of faculty.

Business Impact: At the very least, open microcredentials bring promise of doing what the e-portfolio never quite managed — that is, to create portable recognition for achievements on a global scale. This is a good impact in itself and can improve mobility in the workforce, leading to a better fit between skills and employment.

At the other end, this is another potential threat to the traditional education institutions that rely on the value of government-accredited degrees. If Open Badges is a success (that is, it is accepted by employers), it will make open but individualized programs of study for credit or noncredit stronger in their competition with the many community colleges and public institutions that have limited entrance restrictions and are driven by a clear government mission to provide cost-effective, accessible and relevant education.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Mozilla Open Badges

Recommended Reading: "Governments Need to and Can Play a Role in the Online Claims Ecosystem"

"Gaining Competitive Advantage in the Education Ecosystem Requires Going Beyond Mere Infrastructure to Exostructure"

"Visual Strategic Planning Using the Gartner Higher Education 'Business Model' Scenarios and Corresponding Strategic Technology Maps"

"Reinventing Education Credentials Using Blockchain as a Possible Missing Link for the Open Badge Infrastructure"

Citizen Developers

Analysis By: Mark Driver

Definition: A citizen developer is a user who creates new business applications for consumption by others using development and runtime environments sanctioned by corporate IT. In practice, many organizations are starting to use the term "citizen developer" to refer to any development made by employees/contractors outside the IT organization. Pejorative terms like "shadow IT" or "rogue development" are usually applied by IT to external developments.

Position and Adoption Speed Justification: In an era of shoestring IT budgets, businesspeople are increasingly looking outside the IT organization for applications, as well as building an increasing number of applications themselves. Today's rapidly changing business climate demands greater application agility — IT's timelines are often too long to meet business needs. Although agile development methodologies can help IT respond to business needs more rapidly, a lack of resources often prevents a prompt IT response. Furthermore, resource constraints force IT to focus on only a few high-priority applications. Consequently, the long "tail" of applications needing development grows still longer. In addition, the tacit knowledge of businesspeople is often difficult to translate into project requirements, making IT's application development (AD) projects slow and time-consuming for business end users. Sometimes it is faster, less expensive and better for end users to build the applications they need, rather than engage the IT AD group.

Today, end-user developers are empowered by new forces, including the evolution of developer tools, the industrialization of infrastructure through cloud computing and changing workforce demographics. Many smaller vendors, and some large ones (such as Microsoft and Salesforce), now provide powerful developer platforms that make it easier for end users to develop their own applications — even applications that once required IT AD skills.

Often cloud-based, some of these tools operate completely outside IT's view, requiring only a web browser and a credit card to build, deploy and run an application, and make it available to anyone

with access to the internet. The growth of consumer computing has taught many in the workforce that they don't have to wait for IT to provide the hardware or software needed to do their jobs. These combined forces have resulted in more end-user developers creating more applications of greater scope outside of IT's visibility.

User Advice: IT must engage end-user developers more actively to enable them to become "good citizen developers." The new, more powerful applications that end users are building have the same risks and rewards as some professionally developed applications, and they need an appropriate level of quality, security, performance and availability. Ignoring or attempting to prevent end-user development carries high risks and limits enterprise innovation. Specifically, IT should:

- **Embrace AD outside IT —** Actively challenge and dismantle negative IT attitudes toward end-user AD. "Shadow development" away from IT's oversight generally occurs when working with IT is too slow, restrictive or expensive to meet business needs, not because end users are capricious or malicious.
- **Set clear boundaries —** Be proactive and engage with the business to design a citizen developer program that meets both business and IT needs. Ensure that the rights and responsibilities of IT, the citizen developer and the business are clearly defined.
- **Support safe and effective end-user AD —** Don't just roll out IT's tools to businesspeople. Instead, offer sanctioned development platforms that are end-user-friendly and enable IT staff to manage and monitor citizen development. Extend user support to include citizen development, and measure progress in the volume and sophistication of citizen-developed applications.
- **Trust, but verify —** Provide just enough governance to enable IT to review the quality, security, performance and availability of major end-user applications before they are deployed. Implement monitoring to detect end-user applications that could create risks for the enterprise and develop procedures to handle them. Create a protocol for transferring responsibility for risky and problematic applications to IT.

Business Impact: A citizen developer program that includes IT guidance; IT-supported, end-user-oriented AD platforms; and just enough governance can create a safe environment for end users to unleash their innovative potential. By engaging with end users and helping them to help themselves, IT can accelerate the exploitation of new technology, help end users create competitive advantage and new business innovations, and reduce the risks of modern end-user development.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: IBM; Mendix; Microsoft; Oracle; OutSystems; Salesforce; Servoy; TrackVia

Recommended Reading: "Embracing and Creating Value From Shadow IT"

"Predicts 2015: The Digital Workplace Underscores the Benefits of a Consumerized Work Environment"

Alumni CRM

Analysis By: Terri-Lynn B. Thayer

Definition: Alumni CRM is defined as systems that are used by higher education institutions to engage and serve alumni. The functionality often includes alumni directories, alumni networking, alumni contact management and event management. This functionality may be part of an institutionwide CRM solution, an alumni development fundraising system, an ERP suite or a stand-alone product.

Position and Adoption Speed Justification: Alumni development systems have been in place on many campuses for years, with the primary purpose to support fundraising and a secondary role to support alumni relations. These largely back-office systems supported functions such as campaign management and gift accounting. Alumni engagement and networking activities were supported in a variety of often disparate systems, including printed alumni directories, alumni portals, event management systems, email and Excel. However, there are emerging requirements for sophisticated communications functionality that leverages social media, mobile technologies, digital marketing, online fundraising and analytics. Institutions seek to reap additional value from the alumni community, as well as to appeal to alumni's perceived value of a sustained connection to the institution and the broader alumni network.

Vendors in the student enrollment CRM and student retention CRM space are now leveraging their foundational platforms and CRM expertise to provide alumni CRM product offerings to meet these needs. These products are positioned to support the much-hyped vision of a 360-degree view of a student. Additionally, niche vendors are emerging with alumni CRM point solutions, and social media vendors are capitalizing on their vast following to offer services. Campus stakeholders are not limited to the alumni office, but also include career services, athletics, events management and continuing education — all that have something to gain from having data about, and access to, the alumni community. Most solutions in this space rely on a cloud delivery model and offer extensive social networking integration.

The technology is adolescent today but is rapidly evolving, and as it does, interest and adoption are growing. Alumni CRM has moved quickly past the Peak of Inflated Expectations curve, and product maturity, integration success, analytics support and alumni community interest will likely accelerate the future pace of movement along the Hype Cycle.

User Advice: Classic alumni development systems are mature tools to record alumni demographics and donations, but may not be adequate to meet emerging CRM needs. Institutions should consider all aspects of the student experience and develop a CRM strategy that has a cradle-to-grave perspective relative to the student life cycle. Institutions can no longer afford to have their alumni data isolated in systems that are solely focused on fundraising campaign support. Universities that adopt an institutionwide CRM strategy with integrated technologies will be best-positioned to leverage the long-term value of their alumni. CIOs should review their legacy vendor roadmaps and consider upgrade (as well as replacement) options and/or augmentation with new

alumni CRM solutions. This advice is particularly important for those institutions whose business model is highly dependent on the value proposition of the exclusive alumni network, namely private institutions with high brand equity (see "Introducing Visual Strategic Planning Using Four Higher Education 'Business Model' Scenarios and Strategic Technology Maps").

Business Impact: Alumni CRM technology offers the promise of enhancing alumni engagement, and in doing so, increasing both the degree value to the alumni and increased customer lifetime value for the institution. Interest in lifelong learning is creating opportunities for institutions to utilize this data to grow institutional revenue at a time when the pressures on other traditional revenue sources are acute.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: 360Alumni; Blackbaud; Campus Management; Ellucian; Enrollment Rx; Graduway; iModules; LinkedIn; Salesforce; Symplicity

Recommended Reading: "Achieve a 360-Degree Student View With CRM in Higher Education"

"The Coming of Age for CRM in Higher Education"

"IT Market Clock for Higher Education, 2015"

Adaptive E-Textbooks

Analysis By: Glenda Morgan; Jan-Martin Lowendahl

Definition: Adaptive e-textbooks are tools in which an underlying adaptive platform is closely tied to publisher content. An adaptive e-textbook offers customized student interactions with the digital content based on preferences, or on individual and aggregate achievement data plotted against a learning graph.

Position and Adoption Speed Justification: Adaptive learning is being implemented in a number of different settings. Progress has been made in the algorithms, metadata and learning science underlying adaptive e-textbooks, but more needs to be done to strengthen these components, especially with upper-division courses and in courses with more complex content. With more data, adaptive algorithms will improve. Data privacy and portability could become limiting factors in the growth of adaptive e-textbooks, given the level of granularity with which adaptive systems gather data on users. Providers will need to strengthen security and make transparent efforts to collect only aggregate data.

Adaptive e-textbooks show much promise, but concerns about efficacy and how much providers are able to offer a really personalized learning experience have dulled some of the enthusiasm, leaving adaptive e-textbooks solidly in the Trough of Disillusionment. However, significant

investment in the space, the entry of new vendors, and aggressive experimentation and adoption by campuses mean that the time to the Plateau of Productivity is two to five years.

User Advice: Clearly, adaptive e-textbooks will have an impact on all areas of education, so it would be prudent for all constituencies to prepare by developing IT-led groups (with representation from all stakeholders, but especially faculty and teachers) to determine:

- **Data policies:** What data does the product collect about learners, where is that data stored and at what level of granularity? Is the data shared with any other parties or are there plans to do so?
- **Content vision:** Speak to leading adaptive e-textbook vendors to understand their product roadmaps as well as the learning theory, algorithms, learner data, and analytics and metadata schemes that are used in their products. Users should also explore the content areas that adaptive e-textbook vendors support.

Business Impact: The potential business impact is large, given the effect that adaptive e-textbooks could have on student learning. Adaptive learning truly falls into the high-risk, high-reward category, with a number of stakeholders potentially owning a share of the profits. For publishers, adaptive e-textbooks show a great deal of promise. Most of the larger educational publishers have the resources to invest in building adaptive e-textbooks (for example, McGraw-Hill Education). These rich digital textbooks could allow educational publishers to halt the erosion of existing revenue, as well as show value against lower-cost and free resources.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Cengage Learning; DreamBox; McGraw-Hill Education; Pearson

Recommended Reading: "Adaptive Learning Looms as an E-Textbook Game Changer"

Big Data in Education

Analysis By: Kelly J. Calhoun; Jan-Martin Lowendahl

Definition: "Big data," in general, is defined as high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making. Big data in education is associated with collecting vast amounts of data from students' digitized activities that span many institutions or sources, and transforming that into information and producing or recommending actions aimed at improving the education ecosystem at large and, ultimately, learning outcomes.

Position and Adoption Speed Justification: Big data in higher education has been around for decades, mainly focused on research. However, big data in broader education contexts is more recent, and has been enabled by more and more of our lives being lived and recorded online, as well as being complemented by increasing data volumes from Internet of Things (IoT).

Harvesting this data in sufficient volume and detail can enable the vision of new correlations and, above all, establish the statistical significance between actions and outcomes. Learning platforms can go from "one size fits all" to adaptive learning.

The big data trend will introduce particularly interesting dynamics in the education ecosystem, since, in order for big data to be really effective, the dataset must be bigger than most institutions can collect on their own. The Predictive Analytics Reporting (PAR) Framework (acquired by Hobsons in January 2016) and the adaptive learning tools created by Knewton and Carnegie Learning are examples of capabilities based on proprietary big data. The PAR Framework with its roots in a public organization (Western Interstate Commission for Higher Education) managed to combine data from hundreds of campuses and it now has millions of student records, with 77 defined elements for each record. The PAR Framework project's foresight to release the data definitions as a Creative Commons license can have a major impact in that success. It now remains to be seen how Hobsons manages this heritage and if it continues to be a competitive advantage through transparency over commercial competitors such as Civitas Learning. In addition, big data still have many issues to resolve. What are the implications for privacy laws? Where should the line for anonymization be drawn to be useful for good statistical correlation, as well as for personalized feedback, while allowing for privacy? How does this differ between different cultures?

This means that big data is continuing its descent into the Trough of Disillusionment, as expected. As we learn what works and what doesn't, there is a possibly bumpy five- to 10-year road on the way to the Plateau of Productivity and mainstream adoption. However, that can change quickly if standards mature, and if there is sufficient interest and funding from national and state governments. What is certain is that with the increased focus on learning analytics, institutional analytics (and the algorithms that take us there) and the potential of adaptive learning technologies, the need to collect and manage big data will continue to expand.

User Advice: The greatest big data challenges reside in categorizing the data — making sense of the data, based on or discovering plausible theories or hypotheses, and avoiding pseudocorrelation. However, this is not new to the education community, and research methodologies exist. There is less experience with large datasets in K-12 education, and an additional impediment is fear expressed by stakeholders — especially parents — regarding the possible use of the data outside their educational community.

From a practical standpoint, international collaboration would be immensely facilitated if there were more open standards developed for big data. Examples include SIS International Data Interoperability Standards, Metadata for Learning Opportunities and Open Badge Specification, as well as the opening up of the proprietary standards behind, for example, Knewton's knowledge graphs. The PAR Framework, published under a Creative Commons license, is a particularly good example of how collaboration can be facilitated, using simple, established open-source licenses. A final caveat in this context is that ownership and privacy issues are potentially huge, and must be taken seriously.

Business Impact: Big data is an important piece of the puzzle in solving some of the biggest problems facing education today. Being able to offer the right courses and programs, as well as testing pedagogical approaches to improved learning outcomes based on statistically valid big

data, would be invaluable. Using big data to finally break the logjam of student progress created by archaic seat time requirements in education will pay immediate returns in the efficient and effective delivery of instruction.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Civitas Learning; Hobsons; Intellify Learning; Knewton; Predictive Analytics Reporting (PAR) Framework

Recommended Reading: "Cool Vendors in Leveraging Data in Education, 2015"

"Use Big Data to Fuel Big Change in K-12 Education in 2015"

"The Expanding Education Ecosystem: A World of Choice"

"The Importance of 'Big Data': A Definition"

"A Quick Look at Big Data in Education, 2012"

Student Retention CRM

Analysis By: Terri-Lynn B. Thayer

Definition: Student retention CRM is defined as technology used by higher education institutions to identify and engage at-risk students, assess their progress, create and track engagement plans, and enable successful intervention strategies. Solutions in this space have significantly variable functionality.

Position and Adoption Speed Justification: Student retention CRM is the student life cycle centerpiece bounded on either side by the student enrollment CRM and alumni CRM. The functionality is a combination of analytics for assessing the risk of failure or withdrawal (often referred to as "early alert") and "intervention" tools that assist the academic administration in helping students maintain their registration and academic progression. These applications make heavy use of social and mobile solutions to engage the students. The education industry is struggling to determine exactly what attributes can best predict failures early enough in the process to enable productive intervention. Therefore, despite the hype, student retention CRM systems are still in an adolescent stage. The tools are limited in the types of interventions that they can automate, with many requiring human intervention and thus raising staffing implications.

Administrators are interested in analyzing the reasons why students leave an institution, including those that are not related to academic achievement. Some student retention CRM systems provide the ability to track anecdotal data provided by faculty members (for example, student falls asleep in class), as well as integrate with other campus systems to provide student engagement indicators (for example, utilization of dining hall, library and dormitory). The holy grail is to interface these

student retention CRM solutions with institutional analytics initiatives to improve student outcomes through better curriculum design, student course and concentration selection, and faculty performance. Ultimately, the data mined here may also support predictive analytics for more-effective student recruitment — enabling institutions to select the students most likely to succeed.

There have been a number of recent mergers and acquisitions in this space — some bringing together service offerings with technology solution providers, and analytics components. However, Gartner expects high demand to attract more market entrants. Tremendous anticipation exists that these solutions will solve key problems for higher education. As institutions work through complex implementations, requiring faculty participation to track data and measure true results, Gartner has seen and expects that more disappointments will occur. That is why we have positioned student retention CRM as heading into the bottom of the Trough of Disillusionment.

User Advice: Evaluate student retention offerings from SIS, LMS, CRM and third-party providers. Carefully assess the functions for alerting on academic engagement and success, as well as consider how these systems address nonacademic factors (for example, financial pressures, behavioral problems, and adjustment and maturity issues). Student retention algorithms are still not well-understood. So look for solutions that provide significant flexibility for alerting functions and data analysis techniques, as well as open APIs for integration with a variety of campus systems and external data sources, to ensure investment will have maximum longevity.

Start small with defined objectives. This is likely to be a very iterative space, and it is important to jump in and not get overwhelmed by a "boil the ocean" approach.

Business Impact: In addition to the obvious social good of helping students be successful and receive value for their tuition, it is often more cost-effective to retain a student than to recruit a replacement. For some institutions, even small improvements in retention can significantly mitigate declining enrollment concerns. Such systems will assist institutions in maximizing the student lifetime value and respond to public demands to improve graduation rates and time-to-degree completion.

Most institutions can benefit from improving student engagement, even for students who are academically successful. Increased student engagement during enrollment is an indicator of alumni giving and volunteerism, ultimately making these systems valuable to even the most selective institutions, where retention is not an issue.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Ellucian; Enrollment Rx; Hobsons; Jenzabar; QuScient Technologies; Skyfactor; TargetX

Recommended Reading: "The Coming of Age for CRM in Higher Education"

"Three Important Ways the Analytics Landscape Is Changing in Higher Education"

"Achieve a 360-Degree Student View With CRM in Higher Education"

"Top 10 Business Trends Impacting Higher Education in 2016"

IDaaS

Analysis By: Gregg Kreizman; Neil Wynne

Definition: Identity and access management as a service (IDaaS) is a predominantly cloud-based service using a multitenant or dedicated and hosted delivery model. IDaaS brokers core identity governance and administration, access and analytics functions to target systems on customers' premises and in the cloud.

Position and Adoption Speed Justification: IDaaS market growth accelerated during the past year (see "Magic Quadrant for Identity and Access Management as a Service, Worldwide"). In most cases, IDaaS customers are receiving value for their investments.

There are two primary types of IDaaS:

- Web-centric IDaaS providers focus on brokering identity and access management (IAM) functionality for web-architected applications. Services generally lack the advanced workflow features and legacy application connector support found in traditional user-provisioning tools, as well as identity and access governance functions, such as access certification, segregation of duties controls, and role and entitlement engineering. Lightweight identity governance and administration (IGA) capabilities such as two levels of user provisioning approval workflow and access certification are being added by these vendors.
- Full-featured IDaaS vendors provide support for more than web-based application target systems and the feature sets, particularly for identity governance and administration, have more functional depth than web-centric IDaaS.

Gartner clients' interest in IDaaS has grown rapidly during the past year. Most adoption was for web-centric IDaaS because it resolves a common pain point and it is easy to deploy for a simpler problem set than full-featured IDaaS. Adoption by large organizations has been inhibited by:

- Client concerns about IDaaS vendor security practices and viability
- More-complex requirements and established IAM capabilities within enterprises and, therefore, a preference for maintaining and extending established capabilities
- Data residency concerns

It is also difficult and expensive to transition a heavily customized IAM implementation to the cloud. Thus, IDaaS is headed for the Trough of Disillusionment because the market has not fulfilled its promise or potential to serve as a replacement delivery model for all on-premises IAM implementations. However, its placement also has positive connotations as more organizations

choose IDaaS for the things it can deliver well and for the promise of more advanced features to be delivered over time.

User Advice: Audit and document your assets and costs to manage accounts and entitlements, support authentication, and audit administration and access. These costs can be used when evaluating transition and subscription fees for IDaaS.

Pressure your software as a service (SaaS) providers to develop standard federation capabilities and secure APIs for administration and reporting. Get your SaaS vendors' plans for supporting the System for Cross-Domain Identity Management (SCIM). Plan to make these requirements part of your SaaS buying decisions.

Organizations with functional IGA capabilities and few SaaS application needs should leverage established, internally managed, standards-based federation and automated provisioning, to potentially avoid using IDaaS. However, IDaaS vendors' provisioning, authentication and reporting capabilities may prove to be compelling once SaaS adoption increases, and particularly if your organization is having difficulty maintaining staff with the expertise to manage on-premises IAM software implementations.

Business Impact: Organizations are using IDaaS to fill gaps in enterprise IAM portfolios and IAM staffing functions and to achieve faster time to value. IDaaS can provide a standard, consistent IAM function to support SaaS applications for multiple lines of business with disparate IAM infrastructures inside an enterprise. IDaaS offerings, particularly web-centric IDaaS, may not be able to replace strong, broadly functional IAM solutions in the organizations, but IDaaS may be used to supplement those implementations.

IDaaS functionality is evolving and improving. Some vendors offering full-featured IDaaS have proved that they can deliver the functionality from the cloud that traditionally has been provided by full-featured IAM stacks managed within the enterprise.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Centrify; iWelcome; IBM; Microsoft; Okta; OneLogin; Ping Identity; SailPoint; Salesforce; Simeio Solutions

Recommended Reading: "Magic Quadrant for Identity and Access Management as a Service, Worldwide"

"Use Business Drivers and Cost Analysis to Make IDaaS Versus On-Premises Software Delivery Model Choices"

Master Data Management

Analysis By: Bill O'Kane; Michael Patrick Moran

Definition: Master data management (MDM) is a technology-enabled business discipline in which business and IT work together to ensure the uniformity, accuracy, stewardship, governance, semantic consistency and accountability of the enterprise's official shared master data assets. Master data is the consistent and uniform set of identifiers and extended attributes that describes the core entities of the enterprise, including customers, prospects, citizens, suppliers, sites, hierarchies and chart of accounts.

Position and Adoption Speed Justification: A single trusted version of the data used for master data domains, such as customer, product and asset, remains a central ambition of many organizations in the pursuit of strategic business goals. MDM is a strategic program that can take several years to achieve. The need for business case creation and program management, as well as the ability to deploy information governance and stewardship effectively, restricts MDM success to organizations that master all these requirements. The technical challenge is to bring together the component technical capabilities of MDM (such as for data integration and data quality) in a fashion that supports real business requirements.

The overall market penetration of MDM is still relatively low, due to the complexity of implementation and other organizational and technical barriers, but penetration continues to deepen steadily in specific domains, such as customer and product data. Although MDM as a whole has yet to reach the bottom of the Trough of Disillusionment, it has moved further toward it this year.

This profile of MDM represents an amalgam of the various aspects of MDM that contribute to this discipline's overall position. More specific MDM profiles are included in several other Hype Cycles.

User Advice: Organizations with complex or heterogeneous application and information landscapes are likely to suffer from inconsistent master data. As a result, they are also likely to suffer from a wide range of conditions that weaken business process integrity and outcomes. Any number of business applications may be affected, including customer-facing, supplier-facing, enterprisewide and value chain applications.

If your business strategy depends on the consistency of data within your organization, you may adopt MDM for strategic reasons.

Companies investigating the use of MDM should:

- Ensure a clear "line of sight" to business benefits and business sponsorship. Understand which business initiatives will require better master data to succeed, and explain the need for MDM to appropriate stakeholders.
- Identify specific solutions for the most important master data in your organization, such as customer, product and financial data. Pay particular attention to the industry requirements supported by those solutions. Plan on using them for at least the next two years as the next generation of MDM products emerges (which will include cloud capabilities). Look for solutions

that support a holistic implementation and end-user experience across domains, use cases and implementation styles.

- Identify the architectural role that each implemented MDM solution will play in your approach to enterprise information management (EIM), relative to your information architecture. Use MDM as an opportunity to implement sound information architecture fundamentals, such as canonical transaction formats for master data domains as part of a well-managed data integration practice.
- Use previous experiences in dimensional data development for business intelligence initiatives to identify your organization's most fragmented but reused data domains. Begin your MDM efforts with those domains and expose newly managed master data early in analytics platforms.

Business Impact: Leading organizations that create a strategy to implement MDM and supporting technology that is well-thought-out, holistic and business-driven will be able to deliver significant business value. They will do so in terms of enabling competitive differentiation and business growth, improved customer services, reduced time to market and delivery on operational efficiency, and by meeting governance, risk management and compliance requirements.

MDM strategies that are linked to strategic IT enterprise transformation efforts (such as ERP and CRM implementations) provide significant additional value to those efforts. Conversely, MDM-centric business cases are often used to highlight opportunities for significant business process optimization.

MDM is often the first step toward a well-designed, well-managed EIM program that encompasses supporting disciplines, such as data quality, information governance and enterprise architecture, and an organization's other critical data assets (in addition to master data).

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: IBM; Informatica; Oracle; Orchestra Networks; Riversand; SAP; SAS; Semarchy; Talend; TIBCO Software

Recommended Reading: "The Seven Building Blocks of MDM: A Framework for Success"

"The MDM Solution Market Expands and Evolves"

"Toolkit: A Program Manager's Guide to MDM"

"The Five Vectors of Complexity That Define Your MDM Strategy"

"IT Market Clock for Master Data Management, 2015"

Open-Source SIS

Analysis By: Terri-Lynn B. Thayer

Definition: Open-source education student information systems (SISs) are developed via open-source or community source models.

Position and Adoption Speed Justification: Open-source SIS may be part of a nonproprietary education administrative application suite or a best-of-breed solution. However, features, functionality, processes, integration and support vary widely.

An open-source SIS has long been a collective dream of many higher education institutions, but it has proven hard to achieve. The most ambitious initiative is the Kuali Foundation — over the last dozen years, it developed several administrative systems, but the SIS has been elusive. Last year, the foundation underwent a major restructuring, including the formation of the for-profit company Kuali. Kuali is leading future development of the open-source SIS, but it will retain ownership of the multitenant portion of the code. Last year, Gartner took the position that significant product developments would need to materialize soon for this initiative to remain relevant, or it would risk becoming obsolete before plateau. As no new components of the SIS have emerged, we have declared open-source SIS to be obsolete before plateau.

There are a few other global open-source initiatives, but most are fledgling without mainstream institution adoption and almost no perceptible growth over the last few years. An example is the African initiative, A1 Academia, in production at a handful of higher education institutions. Alternatively, Fedena, developed by India-based Foradian Technologies, has been downloaded by thousands of mostly K-12 schools in lesser- developed education markets such as India, Africa and Latin America. Fedena is available in a SaaS option, integrates with Google Apps and Moodle, and supports many languages. Foradian Technologies offers premium modules and add-ons, such as multischool support, as well as a marketplace for vendor add-ons.

Several European national SIS consortia offer open-source or community source licensing. While the numbers here are small in a global context, they do offer community collaboration and may serve to build support for interoperability components, such as OSS middleware suites and SIS international data interoperability standards. However, many are struggling with the need to update the solutions, especially with a modern UX.

The significant disappointment with the state of OSS SIS today has us placing it directly in the Trough of Disillusionment. As new cloud SIS offerings emerge, they will threaten existing OSS SIS — competing for the mainstream higher education market.

User Advice: The cloud delivery model for software (SaaS) has eclipsed the open-source software movement in both hype and reality. Look for solutions that can be delivered as true SaaS. The availability of local commercial support partners for implementation, hosting and long-term maintenance should be determined. If the ability to participate in community development is a driver for OSS, CIOs should be aware that not all offerings support this model.

Business Impact: Most aspects of student administration will be affected. Benefits may include lower licensing costs, user control of the code and freedom from vendor lock-in. However, these benefits are not always achievable.

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Sample Vendors: A1 Academia; Focus School Software; Foradian Technologies; Kuali Foundation; Learners Circle; OS4Ed; SchoolTool

Recommended Reading: "Market Guide for Higher Education Student Information Systems"

"Market Guide for K-12 Student Information Systems, U.S."

Adaptive Learning Platforms

Analysis By: Glenda Morgan; Jan-Martin Lowendahl

Definition: Adaptive learning platforms dynamically adjust the way instructional content is presented to students based on their responses or preferences. Adaptive learning is increasingly dependent upon large-scale collection of learning data and algorithmically derived pedagogical responses.

Position and Adoption Speed Justification: Adaptive learning has its roots in intelligent tutoring systems from the 1950s, but the increasing ability to capture learner data through online learning has meant a breakthrough. Companies such as Acrobatiq, CogBooks, CCKF (Realizeit), and Smart Sparrow have been working to prove adaptive learning's viability through the development of "adaptive learning platforms," which instructors can use to build adaptive courses using their own content, thus making the course more of a personalized learning experience.

The power of adaptive learning lies with four aspects of the platform: the quality of the metadata attached to each "morsel" of content, the learning theories underlying the adaptive algorithm, the quality of the data informing the development of the algorithm and the algorithm itself. A weakness in any of these undermines the power and promise of adaptive learning.

With a growing number of vendors now offering a variety of approaches, a growing number of institutions are beginning to pilot and roll out courses and supplements to courses built on these adaptive platforms. The reality of the work involved in developing content on the platforms is muting some of the earlier hype, but these institutions are starting to see real benefits in terms of student learning and satisfaction. This merits a start of a move out of the trough toward the Slope of Enlightenment. The time to the Plateau of Productivity will be two to five years.

User Advice: CIOs will play a major role in helping increase the degree of digitization to reach the level where all appropriate learning can be done digitally, allowing the adaptive learning tools to be

used in productive ways. But the key stakeholder will be faculty responsible for adopting and using adaptive platforms. Practical advice for CIOs is to make sure adaptive learning requirements begin to be included in learning environment RFPs and to include faculty and instructors in searching for new adaptive solutions.

A potential challenge to the widespread adoption of adaptive learning is the extent to which privacy regulations will limit the data that can be collected about student learning and used to inform the adaptive system. Finally, it remains to be proven that adaptive learning platforms work with any topic, not just relatively structured topics such as SAT and college math readiness programs, which are behind its current success.

Business Impact: Adaptive learning has the potential partly to solve the problem of "cost-effective scalability while retaining and improving quality."

The ultimate aim of adaptive learning in education is to enhance the learning experience of students, which should result in tangible results such as lower dropout rates in K-12 and higher grades, faster throughput and higher retention, at lower cost to college and university students. A key accomplishment would be if adaptive learning enabled outcomes based on "any paced" learning. These results will benefit students, institutions and society.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Acrobatiq; CCKF; Cerego; CogBooks; Knewton Enterprise; Smart Sparrow

Recommended Reading: "Analytics, Assessment and Adaptive Learning Will Prepare You for the Algorithmic Education Evolution"

Gamification

Analysis By: Brian Burke

Definition: Gamification is the use of game mechanics and experience design to digitally engage and motivate people to achieve their goals.

Position and Adoption Speed Justification: Gamification is beginning to move out of the Trough of Disillusionment. According to Google Trends, the hype surrounding gamification, overall, has been level for about three years. Gartner inquiry volumes have been flat over the past four quarters, with the vast majority of inquiries from clients that are considering using gamification for employee-facing solutions. A shift has occurred in the nature of inquiries on gamification to coalesce around a much narrower set of use cases that dominate inquiry volume, including employee performance — particularly in sales and customer service organizations and employee training. A recent survey indicates that the use of gamification in sales performance management has grown from 2% to 13% over the past two years. This narrower set of use cases will result in repeatable paths to success and move gamification onto the Slope of Enlightenment. Clients are also interested in using

gamification in innovation management (internal and external), customer engagement, collaboration, change management and wellness among others.

User Advice: Gamification builds motivation into a digital engagement model, and can be used to add value to products and to deepen relationships by changing behaviors, developing skills or driving innovation. The target audiences for gamification are employees, customers and communities of interest.

Organizations planning to leverage gamification must clearly understand the goals of the target audience they intend to engage, how those goals align with organizational goals and how success will be measured. Since gamification focuses on helping people achieve their own goals, it engages people on an emotional level, rather than on a transactional level.

Organizations must recognize that simply including game mechanics is not enough to realize the core benefits of gamification. Making gamified solutions sufficiently rewarding requires careful planning, design and implementation with ongoing adjustments to keep users interested. Designing gamified solutions is unlike designing any other IT solution, and it requires a different design approach. Few people have gamification design skills, which remain a huge barrier to success in gamified solutions.

Business Impact: Gamification can increase the effectiveness of an organization's digital business strategy. It provides a means of packaging motivation and delivering it digitally to add value to products and relationships. While many of the concepts in gamification have been around for a long time, the advantage of a digital engagement model provides scale with very low incremental costs. Its use is relevant to sales, marketing, and customer service and training managers, whose aim is to bring about longer-lasting and more-meaningful interactions with customers, employees or the public.

User engagement is at the heart of today's "always connected" culture. Incorporating game mechanics encourages desirable behaviors, which can, with the help of carefully planned scenarios and product strategies, increase user participation, improve product and brand loyalty, advance learning and understanding of a complex process, accelerate change adoption, and build lasting and valuable relationships with target audiences.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Badgeville; BetterWorks; BigDoor; Bunchball; CloudApps; G2G3; GamEffective; Hoopla; LevelEleven

Recommended Reading: "Use Gamification to Improve Sales Performance by Motivating Middle Performers"

"Magic Quadrant for Sales Performance Management"

"Magic Quadrant for Customer Engagement Center Workforce Optimization"

"Market Guide for Innovation Management"

Learning Stack

Analysis By: Jan-Martin Lowendahl; Glenda Morgan

Definition: A learning stack, as an architectural construct, is a collection of elements — such as applications, personal productivity tools, cloud services, content repositories and data sources — that can be accessed through a context platform. The learning stack is dynamic. Elements can be added, updated, removed and replaced in the open structure of the context platform.

Position and Adoption Speed Justification: The development and adoption of the learning stack concept will follow the adoption of the open structure of context platforms and open standards, such as Learning Tools Interoperability (LTI) and the Tin Can API. As the learning platform becomes more generic, the learning stack and the elements in it can become more specialized to academic subjects, in addition to including general-purpose elements. A subject-specific element in the stack may be accessed through the context platform by a specific group of users, thereby making the platform a social learning platform. General-purpose elements in the stack could include cloud services and collaboration tools that are available to all users of the context platform.

Uptake of the learning stack depends on the move away from point solution learning systems and toward a well-developed exostructure with a mature collection of education-specific standards. The learning stack is gaining ground. Increasing interest in new standards (such as Caliper Analytics), and increasing experience in the use of, for example, LTI, shows that institutions and providers now see the learning stack approach as an established design principle, even if it is not yet truly "plug-and-play." The learning stack is through the Trough of Disillusionment and is just on the verge of the Slope of Enlightenment. We expect a pace closer to five years rather than two years to the Plateau of Productivity, due to the need to establish more standards and gain practical experience.

User Advice: When looking to replace learning systems with next-generation context platforms, continue to examine the open structure of the learning platform and its ability to support the learning stack concept. This will ensure that strategic decisions can be made regarding the choice of a platform and elements in the learning stack. Institutions that have introduced application suites, such as Microsoft Office 365 and Google Apps for Education (GAFE), should consider their placement within the learning stack.

Furthermore, when the standards are more mature, technology administrators need to relinquish their tight control and allow users to access applications of their choosing in order for the learning stack to come into its full right.

Business Impact: Providers of learning platforms should offer an open structure to meet users' expectations for easy access to collaboration, communication and content within their learning environments. Publishers of educational digital content will find new opportunities to present subject-specific applications as elements in the learning stack. Students will have more access to

elements in the learning stack to allow for bottom-up use of learning platforms, without requiring faculty members to direct learning activities.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Sample Vendors: Compro Technologies; Instructure; Open Tapestry

Climbing the Slope

Digital Preservation of Research Data

Analysis By: Glenda Morgan; Jan-Martin Lowendahl

Definition: Digital preservation in the higher education community context refers to long-term storage and retrieval — primarily of research data (but also of other born-digital and digitized assets) — in such a way that the viability and usefulness of the data are retained. The objective of digital preservation is to attain or surpass the standard of archiving and retrieval that was set by the handling of paper archives for hundreds of years in some countries.

Position and Adoption Speed Justification: Although the problem of digital preservation has been around for some time, progress in this field has been rather slow due to the pace of change in IT, the perceived high total cost of ownership (TCO) and a lack of monetary ROI. The strategies for addressing the problem are well-developed in theory, but the practical solutions have not been as strong. This has now changed thanks to the fast decrease in storage costs, the emergence of alternative sourcing models (such as the cloud), and the development of standards and tools for the viability of file formats.

A breakthrough was when the "trusted broker" approach was used by the two open-source software repository communities, Fedora Commons and DSpace Foundation, to create the DuraSpace organization and its DuraCloud service. The price list for DuraCloud service shows costs based on storage capacity options and the underlying choice of the public cloud provider. Recently, the conversation about storage at scale and in the cloud has been advanced by the Digital Preservation Network (DPN) and the Academic Preservation Trust (APTrust).

The increasing maturity of the underlying cloud storage services — such as Amazon Web Services (AWS), Rackspace and the Chronopolis service offered by the San Diego Supercomputer Center (SDSC) — already shows that the TCO will diminish over time. However, the real long-term benefits lie elsewhere. The important death-of-distance effect helps research communities come together in an unprecedented way to create critical mass for even small topic areas. The cloud delivery model also brings a disintermediation of the IT departments that, more often than not, speeds up the implementation. Finally, the retrieval of the data is greatly enhanced with the de facto user interface that software as a service (SaaS) inherently brings with it.

More solutions are available, clients are comfortable with this type of SaaS — especially when it has been vetted by trusted brokers, such as Internet2 Net+ (and equivalent national organizations; see MoU Partners) — and, so, a significant number of universities are exploring solutions. Altogether, this merits a jump onto the Slope of Enlightenment this year. We estimate between two and five years to the Plateau of Productivity because the foundation is now solid.

User Advice: Digital preservation is starting to attract a lot of attention, especially from research funding organizations and research-intensive universities. With increased dependence on digital data and more focus on "open access" policies from funders, the principal relevance to research is increasing and, in some cases, even mandated. However, a key problem is that funders still do not yet provide the cash for the sometimes-decades worth of storage and management that is implied in "open access." CIOs should inform researchers that they must include a request for storage funds before they accept the open-access policies imposed by funders.

The increasing volumes of data and potential cost benefits in tiered storage will force institutions to adopt information storage and retrieval strategies that include the digital preservation of research data. The basic strategies now have to include cloud storage options. However, it is important to conduct proper due diligence of external providers, including operational procedures and exit strategies as well as privacy and legal matters.

Digital preservation is about not only storage, but also metadata (to provide sufficient information for reuse by communities), file corruption checks and format viability. It is not always sufficient to store something in the cloud or on tape without some level of significant human resources. Libraries have invested significant efforts to build expertise in these areas, and are natural partners for IT in supporting digital preservation. The automation efforts on that type of work lag far behind the storage capacities. Digital preservation is well-suited for shared services or cloud computing solutions due to the obvious economies of scale, even in due diligence. The cloud option in particular means setting up or finding a broker that is within the academic sphere of trust, such as the DPN, APTrust or DuraSpace.

Business Impact: Success in handling the digital preservation problem in higher education is crucial for future research because more and more data exists only in the digital realm. In the long term, digital preservation has the potential to be transformational for research, especially for its ability to revisit raw data for new interpretations and to access very long series of data.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: APTrust; Digital Preservation Network (DPN); DuraSpace

Wireless as a Service

Analysis By: Jan-Martin Lowendahl

Definition: Wireless as a service (WaaS) in an education context is when an institution buys wireless services from an external service provider to complement or replace its own network access.

Position and Adoption Speed Justification: As more and more education, research and administrative services are delivered as IT services, reliable network access has become not only fundamental, but also critical. We see several clients struggling with infrastructure upgrades just to keep up with bandwidth and access demand as a result of changes in user patterns — for example, bandwidth-hungry video consumption and access-point-hungry mobile devices. However, the real challenge is not campus access, but rather mobile learning. Researchers and students have come to expect seamless "anytime, anywhere" access to K-12 and higher education institutions' IT services, much like telcos' subscription packages and web consumer services. With the increasing dependence on hybrid and online learning, institutions face the challenge of ensuring scalable quality access and support for students who are beyond the confines of the campus.

WaaS has existed for some time, predominantly as a consumer-grade service based on 3G, and several institutions have negotiated deals with telcos to provide or subsidize network access as part of a mobile phone subscription. 3G networks have not had enough capacity and coverage area to be a real alternative to Wi-Fi. However, the increasing availability of 4G, together with corporate subscription services from a few telcos, provides new opportunities to offer students and researchers the cost-effective, ubiquitous bandwidth access that they expect. Some telcos even offer platform as a service (PaaS) as an alternative to run institution-specific applications, which further spreads the risks and increases the options for load balancing and business continuity.

Although the needs are clear for institutionally supported/subsidized WaaS for anytime, anywhere learning, it is entirely possible that the question will become moot. Bandwidth is now a high priority in many families, even in emerging countries, which suggests that this will be entirely covered by market forces.

As the 4G infrastructure matures globally, we expect WaaS to be just another component in the institution sourcing strategy. We see some interest among CIOs to adopt WaaS as a backup to campus Wi-Fi as WaaS becomes a mature alternative. In some emerging countries where the cost of bandwidth is still relatively high, we expect WaaS to be more strategic in order to enable mobile and online learning outside the campus.

This means a steady move for WaaS through the Hype Cycle, which is now past the Trough of Disillusionment and just entering the Slope of Enlightenment. We also expect a rather quick journey of less than two years to the Plateau of Productivity as market dynamics play out.

User Advice: Even if the adoption of WaaS is triggered by a need to provide large groups of students with cost-effective access to institution services, other benefits can be achieved if the right contract is negotiated. This includes ensuring increased bandwidth at the campus by allowing or petitioning the telco to set up access points, thereby creating an independent, redundant network if it's done right. A key issue for researchers and students who travel a lot is still roaming costs. If the institution has remote or international locations, or affiliates that are expected to travel frequently, then a roaming tariff must be included in the contract. Furthermore, because some services will still

require high bandwidth that is not allowed or provided through mobile networks, the option of consolidating home and mobile internet connections should be included in contract negotiations.

Business Impact: The key business benefit is providing real, ubiquitous access to institution services anytime, anywhere — and, in particular, increasing students' transparency regarding the real cost of their education (which is required by law in some countries). Nontraditional students (a segment that is increasing in numbers) who need to combine work and family with studies require true mobile network access in order to be more productive (for example, while commuting). However, this type of infrastructure as a service has an impact on the IT organization's ability to address business continuity, and, ultimately, to provide itself with more sourcing options that enable it to focus its resources and skills on the services that require specific institutional knowledge.

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Sprint; T-Mobile; TeliaSonera

Integration Brokerage

Analysis By: Benoit J. Lheureux; Mary Wilcox

Definition: Integration brokerage (IB) is a category of IT outsourcing for application and data integration projects that includes initial integration project implementations and recurring managed services. IB is often called a B2B or electronic data interchange (EDI) managed service because of its prominent use in e-commerce. Commonly available, IB is also used for cloud service integration, mobile app integration, internal application-to-application (A2A) integration, digital business initiatives and the Internet of Things (IoT) integration.

Position and Adoption Speed Justification: We estimate that more than 2 million companies utilize IB for integration (see "Market Guide for Integration Brokerage"). While most integration projects today have a center of gravity in North America or Western Europe, there is rapid adoption occurring in Latin America and the Asia/Pacific region. Adoption in Latin America is driven in part by e-invoicing government mandates, and in the Asia/Pacific region due partly to IT modernization and e-invoicing projects. This makes IB adoption a global phenomenon.

The most predominant adoption scenario for IB is some form of e-commerce-related supply chain integration. However, there's rapid adoption of cloud service integration projects that are more limited in scope, involving a few cloud and on-premises application endpoints (for example, connecting software as a service [SaaS]-based order management with on-premises CRM applications).

Adoption drivers for IB include macro IT outsourcing, limited availability of B2B/EDI skills, cloud adoption, cloud service brokerage (IB complements aggregation and customization brokerage), implementation of more complex multienterprise projects (for example, vendor-managed inventory and supply chain analytics), modernization of B2B integration projects (which increasingly mix EDI

and API support), the use of IB as an "insurance policy" for future legacy investment protection (the provider must support EDI translation for thousands of companies) and innovation (the provider invests in new approaches, for example, APIs).

User Advice: Before going to market or signing an IB agreement, consider leveraging Gartner's advice on the crucial integration brokerage provider evaluation criteria (see "Negotiate Better Integration Brokerage Agreements With These Essential Best Practices"). Ensure you understand your IB project requirements, so you can negotiate a solid agreement that, at a minimum, addresses:

- Your complete list of trading partners (sorted by strategic importance and country)
- The maps for translation that must be developed; include all transaction, message, file and integration types for both inbound and outbound traffic
- Adherence to published standards and sunset of any legacy standards
- Key reliability and performance milestones (for example, availability of the network, applications and SaaS, APIs and IoT devices)
- Clearly defined SLAs for key milestones and delivery dates (for example, for trading partner onboarding, map development and escalation procedures, for both one-time project implementation and ongoing project management)
- A fast-track pilot (for example, for about six trading partners broadly representing key business requirements, or a few APIs to support mobile apps or IoT devices) to demonstrate early IB project "wins"
- Explicit project reporting and governance (who is responsible for what tasks and how those tasks are tracked) for both initial integration project implementation and ongoing service delivery
- Articulation of what a successful project outcome means to your business and the potential negative impact, if the project outcome is not successful
- Availability of APIs for future B2B, IoT and digital business projects
- A definition of go-forward support processes, including geographical locations supported, hours of operation, SLAs and responsibilities of support

After you've signed an agreement:

- Establish your provider as a strategic partner in the successful outcome of your project.
- Meet regularly with your provider (for example, weekly "stand-up" meetings and monthly detailed progress reports) to monitor the quality and timeliness of key IB project milestones.
- If expectations are not met, work with your provider early on to jointly establish the root cause; then jointly work together (and be willing to improvise) to improve outcomes.
- If expectations are still not being met, escalate — sometimes executive involvement can help.

Business Impact: IB usage and adoption scenarios vary widely and include:

- Traditional e-commerce supply chain integration, for example, for procure-to-pay and order-to-cash processes
- Cloud service brokerage
- Publishing and consuming APIs, for example, to support analytics or to do inventory look-ups
- Data synchronization
- Managed file transfer
- B2B consolidation/modernization projects
- Multinational e-invoicing projects, particularly, in Europe and Latin America
- Internal (A2A) integration projects
- IoT and digital business-related projects, particularly, as an add-on for established B2B projects

IB offers potential benefits for almost all firms — small, midsize or large — across all industries, geographies and scope of e-commerce projects. Projects can range from just a few trading partners to several thousands of trading partners. This is because integration projects are relatively easy to segregate and outsource, and because IB providers have the potential to offer a viable, cost-effective and more consistent alternative to implementing such projects in-house.

The impact of IB will continue to be substantial. Most midsize and large companies will likely still outsource, at least, some of their multienterprise integration and cloud service integration projects, because integration requirements are proliferating and, at the same time, they simply don't have the scale to keep or expand internal integration skills. Through 2017, the complexity and high maintenance cost of internally developed B2B integration projects will drive companies worldwide to outsource 20% to 30% of these projects to IB providers.

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Adaptris; Axway; E2open; HP Enterprise Services; IBM; Liaison Technologies; OpenText (GXS); Seeburger; SPS Commerce; Tieto

Recommended Reading: "Market Guide for Integration Brokerage"

"Negotiate Better Integration Brokerage Agreements With These Essential Best Practices"

"Integration Brokerage Solution Patterns Address Many Integration Problems"

"Toolkit: RFP Template for Integration Brokerage"

Mobile Learning Smartphones

Analysis By: Jan-Martin Lowendahl; Glenda Morgan

Definition: The mobile learning smartphone is about handsets with an identifiable OS that can support installable applications, such as iOS, Windows 10 and Android devices. It encompasses a very broad range of apps, including — but not limited to — media delivery (for example, audio and video), exploratory learning using augmented reality, educational games, collaboration and project work, e-books, surveys, tests, data gathering, real-time feedback, and simulations.

Position and Adoption Speed Justification: Smartphones are already sufficiently capable and numerous in some markets as viable mobile learning tools. A form factor versus function competition will segment the mobile learning market more in the future. For example, some K-12 teachers reject smaller-screen-size phones for reading, while other institutions embrace smartphones as replacements for "clickers" (classroom response systems) because of their size. Further form factor innovation continues to blur the boundaries with "phablets" and "laplets," making smartphone-type interfaces grow to larger devices. In the long term, technologies such as flexible screens will enable an even wider range of portable mobile learning devices.

Technology-aided learning is drawing attention from investors, and a wide range of mobile learning apps continues to hit the market. However, the domain is still maturing surprisingly slowly to understand what type of education is best delivered on mobile devices, and how to integrate mobile learning with traditional education (K-12 and higher education), in classrooms as well as online. At present, mobile learning seems better suited for consumer markets (for example, language learning) than traditional education. Through 2016, adolescent smartphone apps (such as 3D and augmented-reality viewers, smartphone e-book and audio book reader apps, and scriptable mapping tools) offer delivery platforms for educational content, driving increased adoption.

Inhibitors in 2016 still include cost (including data plans in some countries), lack of mobile learning course materials, lack of know-how (usually on the faculty side), and a cultural hesitance in deciding whether the smartphone is a useful learning tool or should be banned outright. EDUCAUSE student survey data from 2015 shows that 92% of undergraduate students (mostly U.S. respondents) had smartphones — 1 percentage point more than students having a laptop. Still, only about a third of faculty members incorporate mobile phones in their assignments.

However, from an equity standpoint, 8% of students not having a required device is still a major inhibitor to any large curriculum changes, because education institutions still have to include a strategy for providing smartphones to all students.

Higher education system providers for administrative and learning systems are increasingly offering mobile apps, which is evidence of their financial commitment to meet the requirements of end users in higher education institutions. Android, iPhone and iPad apps from higher education providers are expected to be the norm. However, most of these apps are still geared more toward administrative or course management tasks than actual mobile learning.

Altogether, this merits a position that is steadily climbing the Slope of Enlightenment as the smartphone finds its form as just another device to increase access to learning services, rather than

as a killer device specific to traditional education. With this definition of the market, we expect mobile learning smartphones to reach the Plateau of Productivity within two years.

User Advice: Many educational institutions have experimented successfully with some form of mobile learning on smartphones. Educators should look for simple apps that can deliver educational materials or assist staff members and students with administrative tasks, such as sending assignment reminders and booking resources (for example, projectors). Educational institutions have the opportunity to increase the accessibility of learning content that better supports problem-based pedagogy, and also leads to better usage of "dead time" (for example, while commuting). The latter convenience is greatly appreciated by part-time learners, which tends to increase student satisfaction and retention.

The growing body of experience has shown that, in some cases, the mobile learning smartphone experiment initiatives have not been properly structured to truly assess the impact of smartphones as mobile learning tools. Failing to structure the experiments in mobile learning smartphones leaves open the questions of the value and effectiveness of specific approaches to mobile learning smartphones. Any institution attempting to experiment with mobile learning smartphones should, therefore, carefully design the assessment phase to confirm or disprove the assumed advantages to specific applications of mobile learning smartphones.

Business Impact: Mobile learning on smartphones or any device is a given component for most education providers today. However, it has gone from a hyped strategic advantage to an expected component for productivity in the classic Hype Cycle manner. Even though there is still much to do before mobile learning smartphones are truly pervasive (especially in traditional K-12 and higher education), it is just that — another channel for pervasive access to learning. Moreover, it has to be incorporated in a much larger ecosystem of capabilities to be truly useful.

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Adolescent

Sample Vendors: Pearson; Signal Vine; Top Hat; WizIQ

Recommended Reading: "Cool Vendors in Education, 2016"

Entering the Plateau

Virtual Worlds

Analysis By: Jan-Martin Lowendahl; Glenda Morgan

Definition: Virtual worlds are online platforms in which participants interact through avatars in a 3D representation of a virtual space. An important special case is open virtual worlds that allow participants to modify the world.

Position and Adoption Speed Justification: For many topics (such as chemistry, biology and astronomy), teaching in three dimensions has obvious pedagogical value. The mix of three dimensions and social interaction that Second Life provided sparked a hype in education that was greater than for most technologies in recent years because of its huge promise in online and hybrid education.

The hype around virtual worlds has diminished considerably in higher education circles, because the general-purpose use of environments such as Second Life has not developed quickly enough from a usability and a business model point of view. The latter in particular has created uncertainty among educators who are looking for other options to safeguard their considerable investments in time in Second Life. However, real pedagogical successes continue in virtual worlds — not for the purpose of making virtual re-creations of real environments, but rather for creating experiences that can take place only in virtual environments, because they would otherwise be, for example, too complex, costly or even dangerous to do in real life.

Second Life, although still used, has given way to other virtual platforms that have proved to be more functional for simulations and experimentation, and whose "business models" are a closer fit to higher education, or have proved to be more sustainable and involve less risk. For example, the open-source projects, such as OpenSimulator, represent the continued interest in and development of virtual worlds that retain the important function of being able to federate virtual worlds. A partly different path is represented by institutions that commission educational games on commercial gaming platforms, or that even buy commercial gaming platforms to develop their own virtual worlds. This latter path appears to add the gamification element to virtual environments, which can be another pedagogical benefit. The existing use of Minecraft in many classrooms (over 7,000 classrooms in more than 40 countries) and Microsoft's pending launch of Minecraft: Education Edition still show a good use case for open virtual worlds in education.

Altogether, this merits a move into the Plateau of Productivity as virtual worlds have reached their potential in their current incarnation catering for a niche market. In order for the open virtual world idea to gain more traction, then new technologies and user interfaces, likely consumerized and ubiquitous (such as the promise of Oculus Rift and Facebook), need to emerge and go through their own Hype Cycle.

User Advice: Use the try-before-you-buy strategy when available, experimenting with proven virtual environment platforms where other institutions have had a measure of success. Expect continued growth of educational gaming and simulation. Encourage faculty and students to sample and explore. Expect simulation and gaming to find a place in the learning stack as subject-specific elements.

Business Impact: There will be effects on analysis, student performance, productivity and agility for knowledge transfer processes, teaching and learning and research support, decision support, training, R&D, intellectual capital management, and innovation.

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: HUBzero; Linden Lab; Microsoft (Minecraft); MindArk (Entropia Universe); Multiverse Software Foundation; Open Cobalt; OpenSimulator; SAIC

SaaS Administration Applications

Analysis By: Terri-Lynn B. Thayer

Definition: Software as a service (SaaS) for administration applications in higher education is software that is owned, delivered and managed remotely by one or more providers, based on a single set of common code, and consumed in a one-to-many model by all contracted customers on a subscription basis. Student information system functionality is excluded from this technology profile.

Position and Adoption Speed Justification: Educational administrative applications delivered through SaaS include major business solutions such as finance and HR, and point solutions such as those for employee recruitment, time and attendance, paycheck processing, and procurement. SaaS architectures are single-tenant, which support one customer per instance of the application, or multitenant, which accommodate multiple customers on a given instance of the application.

Over the past several years, the interest in SaaS has increased dramatically for higher education — with most institutions that are in the market for a new system looking exclusively for SaaS delivery. Typical attractions to the model are its economies of scale, speed of deployment, and opportunities to provide much-needed innovation and agility. Adoption of these solutions has provided evidence for the growing recognition that the business requirements once thought unique to a particular organization can be met without a custom (or customized) solution.

Interest in SaaS offerings is rapidly increasing across the entire spectrum of higher education institutions, from community colleges to major research universities. Higher education institutions are driven to consider SaaS for a variety of reasons, including avoidance of high capital costs and disruption related to major upgrades, staff relief from maintaining a growing portfolio of customizations, and a desire for the consequent standardization of business processes inherent in adopting a SaaS solution. Multitenant solutions are, by design, often free of customization, and the institution benefits from frequent introduction of new functionality. However, the institution typically has limited control over the schedule of these upgrades. The increased interest in SaaS for administrative applications is now being met with an increase in vendor offerings.

Barriers to adoption are decreasing but may include cultural proclivities, and legal and security concerns around local storage of data. Vendors are specifically addressing these concerns with offerings that guarantee location of data within country. Early adopter institution success has further fueled confidence.

We have reached the turning point beyond where institutions are no longer deciding "if" they will go to the cloud for these applications but "when." Gartner has positioned this in the early plateau and expects demands for increased efficiency and accountability to drive institutions to common

business practices, further accelerating adoption and rapidly propelling this firmly into the plateau in less than two years.

User Advice: Best practices for considering administrative application requirements are re-examining business needs, and considering process and technology changes to meet business requirements. Build a business case to satisfy those business requirements with SaaS solutions, and be sure to calculate the total cost of ownership. Be mindful that SaaS may not be a cost saver, especially for the first major system that is moved to the cloud. However, over time as more components are shifted to SaaS, there should be cost- reduction opportunities related to the decommissioning of on-premises infrastructure and redeployment of staff resources to more strategic initiatives.

Assess institutional readiness to move from a capital-expenditure-heavy on-premises upgrade environment to a more predictable operating expenditure model in the cloud. Key elements of technical readiness should also be assessed, including network capacity and reliability, as well as strong integration tools, skills and architecture.

The key decision will often be reduced to balancing calls for customized, highly enterprise-specific requirements — and the costs that accompany them — versus the opportunities that may be offered through the adoption of more standard business practices through SaaS. Flexibility, control, service levels, configurability and scalability should all be carefully considered when selecting a SaaS solution.

Business Impact: SaaS offers academic institutions the opportunity to identify and concentrate on analyzing and using essential data without saddling them with the hardware, software and staffing requirements that accompany on-premises solutions. Education institutions that want to adopt industry best practices, modern user experiences and enhanced analytics will benefit from SaaS. Institutions interested in quality, agility and innovation report the greatest interest in SaaS.

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Campus Management; Kronos; Oracle; SAP; Ultimate Software; Unit4; Workday

Recommended Reading: "Higher Education CIOs: Renovate your ERP Core for Digital Business"

"Change Your ERP and Business Applications Support Strategies as You Move to the Cloud"

Cloud HPC/CaaS

Analysis By: Jan-Martin Lowendahl

Definition: Computing as a service (CaaS) or cloud high-performance computing (HPC) in higher education deals primarily with on-demand delivery of moderate to massive computing power for education or research purposes.

Position and Adoption Speed Justification: Cloud HPC or CaaS is a natural extension of grid computing for many higher education institutions. Many institutions also collaborate in the HPC area and have already established "shared-service HPC." This means that cultural acceptance of cloud HPC/CaaS is high. Further advantages include the classic "cloudonomics," such as electricity and cooling savings, pay as you go, rightsizing, and "right timing" (on-demand), countered by the usual drawbacks regarding, for example, intellectual property (IP) protection and privacy. The most interesting effect is how cloud HPC/CaaS is increasing the availability of HPC to smaller institutions and even to students. The interest is at a high level, and several institutions are including cloud HPC in particular in their sourcing strategies.

Cloud HPC/CaaS has entered the next phase, focusing on establishing practical processes and services on a larger scale. For example, established grid organizations, such as the European Grid Infrastructure (EGI), are transforming existing grids into "cloud computing" through the EGI Federated Cloud Task Force. Even more interesting, the Helix Nebula Initiative is a step toward a European cloud-based scientific "e-infrastructure," which aims to bring together several providers — commercial and public — to create a viable competitive market of cloud services. Several well-known organizations and vendors are involved, such as CERN (the European Organization for Nuclear Research), the European Space Agency, BT Global Services, Atos and Capgemini. Niche players — such as UberCloud, and Open Science Grid, which helps academics find suitable cloud HPC services — have entered the market. Privacy-related concerns, such as the Edward Snowden-National Security Agency incident, have delayed some of these cloud efforts, but there is still a steady path to maturity beyond the Hype Cycle.

Cloud HPC/CaaS is in the Plateau of Productivity. Problems are ironed out, and practical experience separates hype from reality.

User Advice: To move to cloud HPC/CaaS, institutions must understand their current total cost of ownership and risk level, and they must conduct due diligence to check up on the intended provider (regardless of whether it is a nonprofit shared-service consortium or a commercial vendor) on issues such as IP, privacy, security, storage and backup. Data loss incidents from services such as Dedoose show that due diligence and a good contract with appropriate penal clauses are crucial best practices for any kind of external sourcing.

Given the increased awareness of privacy issues, it is advisable that the education CIO make sure key stakeholders and users are well-informed before starting to use these services. Cloud HPC/CaaS options are most valuable for institutions that face special circumstances, such as short-term projects, variable computing demands and limitations in power grids (as in downtown London). Institutions that are involved in cloud HPC/CaaS often, but not always, need to combine it with storage as a service. One capability that will likely rise in importance with cloud HPC/CaaS is network technology, which reduces latency and improves security.

Another change for some institutions is that they should factor in the bandwidth costs explicitly, because many commercial services charge directly for that component, which has been "no fee" at

the end-user level in most countries with an established national research and education network. In fact, a detailed understanding of the contract and what is chargeable is very important, as some providers are innovative in what activities cost money.

Business Impact: The impact on higher education is high, because cloud HPC/CaaS puts more computing power in the hands of more students and researchers. Furthermore, it can act as a democratization force for institutions globally. The convenience factor is high and will probably lead to increased collaboration regarding computing-intensive research and education. If cloud HPC/CaaS can also be combined with subject-specific services, such as Gaussian as a service (for molecular calculations), and support from parallelization expertise for optimizing the code for the cloud, then it has the potential to speed up research cycles and tremendously increase accessible data volumes.

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Amazon; Dell; Google; IBM; Microsoft

E-Textbook

Analysis By: Kelly J. Calhoun; Glenda Morgan

Definition: E-textbooks are defined as content delivered electronically on user devices. Unlike traditional print materials, e-textbooks can be edited to include up-to-date information, be assembled or disassembled to rearrange the sequence or to include content from other sources, or offer multimedia representation of information and instructional exercises. They also can allow users or teachers to insert or respond to personal notes or diagrams as study aids.

Position and Adoption Speed Justification: The momentum toward the adoption of e-textbooks comes from: (1) educators' views of digital content as a means of staying current in content areas and of keeping students engaged; (2) an increasing number of relatively inexpensive, small form-factor devices (personally or institutionally owned) available for deployment in educational settings; (3) growing interest in self-publication given the availability of platforms that enable this; and (4) new efforts to find viable business models for textbooks.

State education agencies, such as those in California and Florida, have mandated or are considering requirements to replace print with digital content, and publishers are racing to get to market first.

The migration from print to digital content is viewed as a question of "when, not if," but not all education agencies are truly ready for the transition. In K-12, although mainstream textbook publishers are now making access to the digital version of the textbook standard (hence making e-textbooks more "ubiquitous"), sufficient access to devices to view them on, either student or institution-owned, remain the barrier to true "ubiquity." Several large universities are striking deals

with publishers to bring down total cost and ensure availability of e-textbooks, although digital versions of all content are not guaranteed.

The nonadaptive nature of e-textbooks and their common availability (although not necessarily ubiquitous use), both in higher education and in K-12, have positioned them to move forward to the Plateau of Productivity.

User Advice: The business case for e-textbooks becomes stronger as the capital cost of user devices decreases, support and infrastructure resources are put in place, and current content providers either offer economical licensing agreements or get pushed aside by content providers willing to do so. The proliferation of general-purpose tablets and other mobile user devices has increased in K-12, particularly with significant growth in Chromebooks in the last year. Primary and secondary technology leaders should partner with curriculum planners to develop a business case that includes replacing print with e-content deployed to personally owned or assigned student devices. Institutions of higher education are likely to see wider adoption first in the use of e-textbooks that are electronic forms of print versions because of the wider availability of applications for user devices and because the content selection process will not require change.

In addition, new models are arising for "pay-per-use textbook rental" services, such as newly founded Packback. This addresses a key obstacle to broader e-textbook adoption by pulling back some of the revenue lost to the used-book resale market, and allowing students to utilize the textbook (or buy it later, if needed) as and if they need it, at a lower cost. Stay tuned to these developments.

Business Impact: E-textbooks will become the preferred content delivery mechanism throughout public and private education agencies and institutions. School organizations that provide digital content resources to students will be relieved of the liabilities of physical inventory, storage, distribution, repair (rebinding) and replacement because of loss. The conflux of decreases in device cost, the availability of multiple device form factors that can put e-textbooks in the hands of users and consumer adoption of similar technologies are driving adoption.

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Amazon; Apple; Houghton Mifflin Harcourt; McGraw-Hill Education; Pearson (LearningStudio)

Recommended Reading: "Top 10 Strategic Technologies Impacting Higher Education in 2016"

"Top 5 Strategic Technologies Impacting K-12 Education in 2016"

BYOD Strategy

Analysis By: Kelly J. Calhoun; Glenda Morgan

Definition: Bring your own device (BYOD) is becoming a dominant practice in higher education (and a pioneering one in K-12) in developed countries, and is growing worldwide. BYOD in this context means BYOD as a *deliberate, defined strategy*, as opposed to providing standardized devices, which was popular in the past. BYOD presents IT organizations in education with multiple challenges, but also provides multiple benefits.

Position and Adoption Speed Justification: CIOs in higher education and K-12 live in a world of diverse consumer devices, which continues to get more diverse with time. The shift away from rigidly standardized devices (single platforms or device types) toward designing for more heterogeneous environments has only gained momentum in recent years.

Educators in K-12 must address equity as an issue, especially when digital delivery of instruction is required. In higher education, the BYOD discussion is widening to include "bring your own everything," including devices and services (for example, cloud storage systems such as Dropbox or figshare). This relates closely to the Gartner term "consumerization" and puts even greater strain on the IT department. Real-world experience has accumulated — BYOD strategy has reached the Plateau of Productivity, since, for students and faculty, BYOD is a reality.

User Advice: CIOs are finding that BYOD strategies are necessary, and they want to willingly support them as a benefit for students, the institution or the district. The recognition of the numbers and types of devices in your environment — and the variety of users relying on being able to use those devices throughout the day —requires careful thought and planning to create a flexible and adaptive infrastructure that can meet those needs. For IT organizations to effectively support a BYOD organization, the security of the network and applications must be solid. Moreover, systems that customers interface with must be capable of transacting business in all major devices and OSs, or the mobility strategy must be built around a common denominator protocol like HTML5. The situation is similar to that of SMS or texting: Texting is ubiquitous because it is device-, network- and OS-neutral, and works virtually everywhere on most handheld devices.

A mobility strategy for BYOD must be the same. It must work with almost any device with a browser to be acceptable. Use of browser-based technologies, while often not the same aesthetic as OS-based options, is ubiquitous and allows generalized mobility. The multi-OS problem is accentuated in education, because students can be expected to bring a much more varied set of devices compared with a corporate environment.

With such approaches as a virtualized (cloud) desktop and the use of the functionality of server-based computing, such as Citrix, even devices of relatively limited functionality can be effectively utilized in a well-designed environment. It may be useful to maintain a relatively small application group to build institution-specific applications offered through the campus's own app store.

Business Impact: With the acceptance of the consumerization of technology, and the near-universal acceptance of the use of personal devices to access and interact with enterprise systems, IT directors are embracing the trend of pushing transaction processing to the users (thereby, making a virtue out of a necessity). It is a reversal of the 40-year trend of IT having to maintain all tools for collecting and processing data, and is a key step toward embracing an exostructure strategy (see

"Gaining Competitive Advantage in the Education Ecosystem Requires Going Beyond Mere Infrastructure to Exostructure").

Benefit Rating: Moderate

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Sample Vendors: Modo Labs; Sourcebits

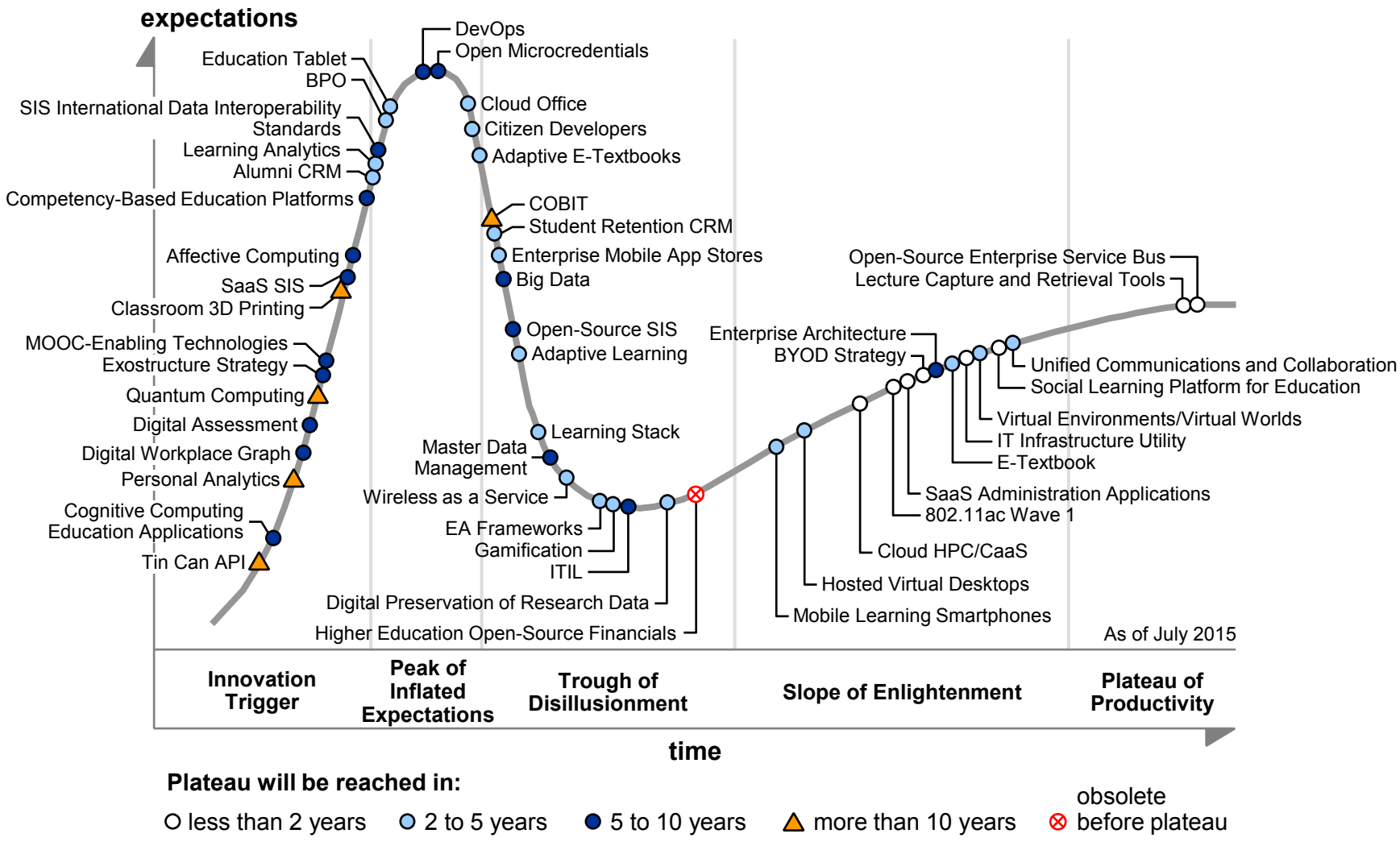
Recommended Reading: "BYOD in Education by Design, Not Default"

"The Impact of BYOC on Management and Support"

"How to Create a Bring-Your-Own-Device Policy"

Appendixes

Figure 3. Hype Cycle for Education, 2015



Source: Gartner (July 2015)

Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 1. Hype Cycle Phases

Phase	Definition
Innovation Trigger	A breakthrough, public demonstration, product launch or other event generates significant press and industry interest.
Peak of Inflated Expectations	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the technology is pushed to its limits. The only enterprises making money are conference organizers and magazine publishers.
Trough of Disillusionment	Because the technology does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
Slope of Enlightenment	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the technology's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
Plateau of Productivity	The real-world benefits of the technology are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
Years to Mainstream Adoption	The time required for the technology to reach the Plateau of Productivity.

Source: Gartner (July 2016)

Table 2. Benefit Ratings

Benefit Rating	Definition
Transformational	Enables new ways of doing business across industries that will result in major shifts in industry dynamics
High	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise
Moderate	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise
Low	Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2016)

Table 3. Maturity Levels

Maturity Level	Status	Products/Vendors
Embryonic	▪ In labs	▪ None
Emerging	▪ Commercialization by vendors ▪ Pilots and deployments by industry leaders	▪ First generation ▪ High price ▪ Much customization
Adolescent	▪ Maturing technology capabilities and process understanding ▪ Uptake beyond early adopters	▪ Second generation ▪ Less customization
Early mainstream	▪ Proven technology ▪ Vendors, technology and adoption rapidly evolving	▪ Third generation ▪ More out of box ▪ Methodologies
Mature mainstream	▪ Robust technology ▪ Not much evolution in vendors or technology	▪ Several dominant vendors
Legacy	▪ Not appropriate for new developments ▪ Cost of migration constrains replacement	▪ Maintenance revenue focus
Obsolete	▪ Rarely used	▪ Used/resale market only

Source: Gartner (July 2016)

Gartner Recommended Reading

Some documents may not be available as part of your current Gartner subscription.

"Understanding Gartner's Hype Cycles"

"Predicts 2016: Building the Foundation for the Digitalization of Education"

"Cool Vendors in Education, 2016"

"2016 CIO Agenda: A Higher Education Perspective"

"2016 CIO Agenda: A K-12 Education Perspective"

"Executing a Digital Strategy in Education Primer for 2016"

"Innovating Administrative Systems in Education Primer for 2016"

"Innovating Learning Environments in Education Primer for 2016"

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