



Horizon Project

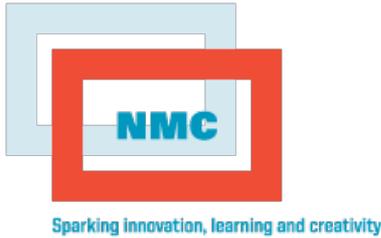
2014 NMC Technology Outlook

Brazilian Universities

A Horizon Project Regional Report



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2014 NMC Technology Outlook for Brazilian Universities *A Horizon Project Regional Report*

is a collaboration between

The New Media Consortium

and

Saraiva

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A Horizon Project Regional Report

Executive Summary

The *2014 NMC Technology Outlook for Brazilian Universities: A Horizon Project Regional Report* reflects a collaborative research effort between the New Media Consortium (NMC) and Saraiva to help inform education leaders in Brazil about significant developments in technologies supporting teaching, learning, and creative inquiry in higher education.

All of the research underpinning the report makes use of the NMC's Delphi-based process for bringing groups of experts to a consensus viewpoint, in this case around the impact of emerging technologies on teaching, learning, and creative inquiry in higher education institutions in Brazil over the next five years. The same process underlies the well-known *NMC Horizon Report* series, which is the most visible product of an on-going research effort begun more than 12 years ago to systematically identify and describe emerging technologies likely to have a large impact on education around the globe.

The *2014 NMC Technology Outlook for Brazilian Universities* was produced to explore emerging technologies and forecast their potential impact expressly in a higher education context. In the effort that took place from August through September 2014, a carefully selected panel of experts was asked to consider hundreds of relevant articles, news, blog posts, research, and project examples as part of the preparation that ultimately pinpointed the most notable emerging technology topics, trends, and challenges for Brazilian universities over the next five years.

Known as the 2014 Horizon Project Brazil Expert Panel, that group of thought leaders consists of 41 distinguished individuals, all highly regarded in their fields. Collectively the panel represents a range of diverse perspectives across the education sector for Brazilian higher education. The project has been conducted under an open data philosophy, and all the interim projects, secondary research, discussions, and ranking instrumentation can be viewed at brasil.wiki.nmc.org. The precise research methodology employed in producing the report is detailed in a special section found at the end of this report.

Table 1: Comparison of “Final 12” Topics Across Three NMC Horizon Research Projects

NMC Horizon Report 2014 Higher Education Edition	2014 NMC Technology Outlook Brazilian Universities	2013 NMC Technology Outlook Latin American Universities
Time-to-Adoption Horizon: One Year or Less		
Bring Your Own Device Flipped Classroom Learning Analytics Massive Open Online Courses	Flipped Classroom Games and Gamification Mobile Apps Online Learning	Collaborative Environments Online Learning Open Content Social Media
Time-to-Adoption Horizon: Two to Three Years		
3D Printing Games and Gamification The Internet of Things Wearable Technology	Learning Analytics Mobile Learning Open Content Virtual and Remote Laboratories	Augmented Reality Learning Analytics Mobile Learning Personalized Learning
Time-to-Adoption Horizon: Four to Five Years		
Affective Computing Flexible Displays Quantified Self Virtual Assistants	Augmented Reality The Internet of Things Location Intelligence Virtual Assistants	3D Printing The Internet of Things Machine Learning Virtual and Remote Laboratories

The 12 “technologies to watch” presented in the body of this report reflect our experts’ opinions as to which of the nearly 60 technologies considered will be most important to Brazilian universities over the five years following the publication of the report. As Table 1 above illustrates, the choices of our experts overlap in interesting ways with those who contributed to the *NMC Horizon Report > 2014 Higher Edition*, which looked at technology uptake in universities and colleges from a global

perspective, and the *2013 NMC Technology Outlook > Latin American Higher Education Edition*, which provides perspective on the technologies impacting the Latin American region.

All three of these projects' expert panels — a group of 131 acknowledged experts — agree that online learning, in some form, will likely tip into mainstream use within the next year — a trend that spans education across much of the world. Brazilian universities epitomize this trend as they are frequently partnering with organizations such as Veduca and Coursera to provide more open online learning opportunities to increase access to high-quality education.

Additionally, the Brazilian and Latin American panels demonstrated consensus around learning analytics being two to three years away from widespread penetration. Many universities in Brazil are starting to pilot learning analytics tools that have built-in analytics to track student learning progress and behavioral patterns, making it easier to identify where they need extra help. The next incarnation of learning analytics is adaptive learning, where the environment responds to individuals' behavior by recommending articles or activities, for example, to a student that has demonstrated the need for more time to grasp the material. Saraiva is developing one such platform to prepare Brazilian students for civil service exams.

The same two expert panels perceive mobile learning to be in the mid-term horizon; however, research for this report indicates that there is still a need for better mobile broadband, along with national and university policies that encourage the effective use of smartphones and tablets in Brazilian higher education. Preparations for hosting the 2014 World Cup strengthened the cellular network, which has been an important precursor for mobile learning. The Brazilian Ministry of Communications recently approved projects worth BRL450 million to deliver LTE-450 to municipalities in 14 states. However some educators still view mobile devices as classroom distractions and not as valuable learning tools.

While there are several other overlaps between the panels, there are some differences between perceived time-to-adoption horizons. For example, the Horizon Project Brazil Expert Panel feels that games and gamification are in the near-term, while the global 2014 Horizon Project Higher Education Panel believes that it is further out at two to three years. There are several examples of Brazilian universities, such as University of Campinas, that are already working on educational games and game apps to help students learn complex subjects, in addition to government-led contests that invite Brazilian residents to design games. These programming and design skills are increasingly valued and are being incorporated into national initiatives and university curriculum.

Table 2: Top-Ranked Trends Across Three NMC Horizon Research Projects

NMC Horizon Report 2014 Higher Education Edition	2014 NMC Technology Outlook Brazilian Universities	2013 NMC Technology Outlook Latin American Universities
Integration of Hybrid Learning Designs	Integration of Hybrid Learning Designs	Growing Ubiquity of Social Media
Rise of Data-Driven Learning and Assessment	Digital Delivery is Increasingly the Norm	Integration of Hybrid Learning Designs
Evolution of Online Learning	Massive Reinvention of the Personal Computer	Rethinking the Roles of Educators

The Internet of Things made the list of technologies for all three panels, though it is worth pointing out that the global panel perceives it as garnering widespread adoption several years sooner. Universities in Brazil are beginning to investigate the potential educational applications of

networked objects. Several Brazilian companies are hosting hackathons and funding projects that stimulate the conceptualization and development of Internet of Things products.

Open content, selected in the near-term horizon by the 2013 Latin American panel, is positioned by the Brazilian panel in the mid-term horizon. This movement is spreading across Brazil as initiatives such as Open Knowledge Brazil and Recursos Educacionais Abertos reflect a national goal to provide more learning opportunities at no cost. Both the Brazilian and Latin American panels agree that virtual and remote laboratories are changing the way students learn STEM (science, technology, engineering, and mathematics) subjects, but the Brazilian panel sees the technology progressing sooner. Universities there are leveraging online and hybrid learning trends, including the flipped classroom model, by making it easier for students to run science experiments as often as they like, from wherever they are. Remote labs are exposing students to high-caliber equipment from universities around the world.

There were two distinct choices that distinguished the viewpoints expressed by the 2014 Horizon Project Brazil Expert Panel from their counterparts: mobile apps and location intelligence. Mobile apps are seen as valuable tools for social networking, health tracking, and more, and Brazilian universities are increasingly becoming incubators for app development. Even students are designing apps and gaining vital computer science skills along the way. The addition of location intelligence takes these apps to the next level, providing helpful information and services to users based on their whereabouts.

Table 3: Top-Ranked Challenges Across Three NMC Horizon Research Projects

NMC Horizon Report 2014 Higher Education Edition	2014 NMC Technology Outlook Brazilian Universities	2013 NMC Technology Outlook Latin American Universities
Low Digital Fluency of Faculty	Increasing Access to Education	Competition from New Models of Education
Reducing the Technology Gap Between Teachers, Tutors, and Students	Reducing the Technology Gap Between Faculty and Students	Lag in Appropriate Learning Evaluation Metrics
Increasing Access to Education	Keeping Education Relevant	Low Digital Fluency of Faculty

The nuances of the technologies and their associated adoption horizons featured in this report are specific to universities in Brazil, even if there are commonalities with other reports. Likewise, the key trends (Table 2 and pages 17-18) and significant challenges (Table 3 and pages 19-20) selected by the 2014 Brazil panel distinctly reflect the current drivers and obstacles facing Brazilian universities over the coming five years. The top three trends and challenges from those longer lists are included in the related tables in this summary, and are organized by time-based categories described in the corresponding sections of this report.

According to the Horizon Project Brazil Expert Panel, the integration of hybrid learning is a growing trend in their universities. Today, it is highly uncommon for a school to not have an online presence. Social media use, along with open content, are proliferating across the Internet, making it easier for faculty and students to discover relevant and timely resources while sharing their own. This trend has also sparked new learning approaches, such as the flipped classroom, in which much of the lectures and curriculum are placed online for students to access from home so that class time can be devoted to more hands-on and immersive activities.

Additionally, the massive reinvention of the personal computer is making technology more prominent in teaching and learning across higher education in Brazil. Faculty and students are no longer tied to desktop computers, mice, and keyboards; smartphones and tablets are making it easier for them to discover, share, and create educational resources, on and off campus. eMarketer predicts that Brazil will have a smartphone penetration rate of 36% by the end of 2014, with an increase of 10.9 million more smartphone owners.

Horizon Project panels in general have agreed that trends like these are clear drivers of technology adoption; the Brazil panel especially saw such a linkage. At the same time, these panels of experts also agree that technology adoption is often hindered by both local and systemic challenges, which are grounded in everyday realities that make it difficult to learn about, much less adopt, new tools and approaches.

The panel agreed that increasing access to education is imperative as not all of the Brazilian population can afford to enroll in higher education institutions. Online learning and open content are seen as vehicles for solving this problem and extending learning opportunities to more people, though not everyone in the country has sufficient Internet access yet and WiFi is not always free.

The panel also believes that reducing the technology gap between faculty and students is an imperative but difficult challenge to solve. While the current and incoming generations of students are already familiar with mobile devices, social networks, and other technologies having grown up with them, many faculty do not have the same natural inclinations. Furthermore, technology training is not prevalent in pre-service education for teachers and instructors across Brazil. There is a need for programs where faculty can continuously learn how to use new technologies and discover creative ways to integrate them into their curriculum.

Keeping education relevant is perceived by the Brazil panel as a wicked challenge — one that is hard to define, let alone solve. Informal learning venues in the form of MOOCs and the Khan Academy are calling into question the necessity of brick-and-mortar universities as students can now learn new skills from anywhere. The value of the degree is being called into question, especially as vocational education minimizes the amount of time students spend in school and the money they invest there. Determining ways to make education more affordable and exposing students to real world training they cannot get anywhere else is key to mitigating this issue.

These points and comparisons provide an important context for the main body of the report that follows this summary. There, 12 key technologies are profiled, each on a single page that describes and defines a technology ranked as very important for Brazilian universities over the next year, two to three years, and four to five years. Each page opens with a carefully crafted definition of the highlighted technology, outlines its educational relevance, points to several real life examples of its current use, and ends with a short list of additional readings for those who wish to learn more. Following those discussions are sections that detail the expert panel's top ranked trends and challenges, and frame them into categories that illuminate why they are seen as highly influential factors in the adoption or proliferation of any of these technologies over the coming five years.

Those key sections, and this report in general, constitute a reference and straightforward technology-planning guide for educators, researchers, administrators, policy makers, and technologists. It is our hope that this research will help to inform the choices that institutions are making about technology to improve, support, or extend teaching, learning, and creative inquiry in Brazilian higher education. Education professionals worldwide look to the NMC Horizon Project and both its global and regional reports as key strategic technology planning references, and it is for that purpose that the *2014 NMC Technology Outlook for Brazilian Universities* is presented.

Time-to-Adoption: One Year or Less

Flipped Classroom

The flipped classroom refers to a model of learning that rearranges how time is spent both in and out of class, shifting the ownership of learning from the educators to the students. In the flipped classroom model, valuable class time is devoted to more active, project-based learning where students work together to solve local or global challenges — or other real-world applications — to gain a deeper understanding of the subject. Rather than the instructor using class time to dispense information, that work is done by each student after class, and could take the form of watching video lectures, listening to podcasts, perusing enhanced e-book content, or collaborating with peers in online communities. Students access the online tools and resources any time they need them. Faculty can then devote more time to interacting with each individual. After class, students manage the content they use, the pace and style of learning, and the ways in which they demonstrate their knowledge; the instructor adapts instructional and collaborative approaches to suit their learning needs and personal learning journeys. The goal is for students to learn more authentically by doing. The flipped classroom model is part of a larger pedagogical movement that overlaps with blended learning, inquiry-based learning, and other instructional approaches and tools that are meant to be flexible, active, and more engaging for students.

Relevance for Teaching, Learning, or Creative Inquiry

- Flipped classroom concepts, along with providing students with a more diverse set of learning resources, support self-directed learning.
- More active learning is an important component of the flipped classroom: lectures are watched with ensuing online discussions unfolding at home, while professors use class time for hands-on activities or trips outside of the building.
- The online component of the flipped classroom enables students to repeat vital learning activities, such as re-watching video lectures and running virtual experiments as often as needed, in order for them to fully grasp the subject matter.

Flipped Classroom in Practice

- Educação de Bom Despacho and the Universidade Federal de Itajubá are part of an 18-member consortium of institutions investing in a flipped classroom model in which students access content at home: go.nmc.org/minas.
- Students at the Singularity Institute study university lecture material at home and then discuss the content with their peers and teachers during class: go.nmc.org/insing.
- Uniamérica, Foz do Iguaçu restructured their pedagogical approach by making lecture material available before class in an online video platform: go.nmc.org/abole.

For Further Reading

Colleges in the Valley Borrow Teaching Methods from Harvard

go.nmc.org/vale

(*The G1*, 18 March 2014.) In flipped classrooms at universities in the Paraíba Valley, new classroom layouts enable students to be more effectively grouped together in discussion circles rather than in rows. Instructors in both humanities and technology areas are currently experimenting with these new arrangements.

States to Find the Ideal Methodology

go.nmc.org/vidauni

(Adriana Czelusniak, *Gazeta de Povo*, 21 July 2014.) The post explores new educational methodologies such as the flipped classroom, where teaching becomes more dynamic and interactive. Students benefit by learning how to work in groups and to seek solutions to pressing problems.

Time-to-Adoption: One Year or Less

Games and Gamification

The culture around digital games is growing to encompass a substantial proportion of the world's population, with the age of the average gamer increasing every year. The gaming industry is producing a steady stream of games that continue to expand in their nature and impact — they can be artistic, social, and collaborative, with many allowing massive numbers of people from all over the world to participate simultaneously. A 2013 study by the American Psychological Association highlights the cognitive, motivational, emotional, and social impact video games have on human behavior; this significant body of research underlines the overwhelming potential of games to teach new forms of thought and behavior. Studies like these are encouraging the uptake of games into the worlds of commerce, the military, and education, among others. Gamification — the integration of gaming elements, mechanics, and frameworks into non-game situations and scenarios for training and motivational purposes — has added another level of complexity to discussions surrounding the potential of games to transform teaching and learning. The gamification of learning environments is gaining support among educators who recognize that effectively designed games stimulate large gains in engagement, productivity, creativity, and authentic learning.

Relevance for Teaching, Learning, or Creative Inquiry

- Discovery-based and goal-oriented learning are often inherent in educational games and gamified experiences, fostering opportunities for collaboration and the development of teambuilding skills.
- Educational games are used to teach cross-curricular concepts that touch on many subjects, and often are more engaging than traditional approaches.
- Simulations and role-playing games allow students to re-enact difficult situations to try new responses or pose creative solutions.

Games and Gamification in Practice

- The Dutch Waag Society and the Brazilian Mobilefest designed a mobile game called "Gicana" that teaches Brazil's culture and history through location-based activities: go.nmc.org/jamify.
- Electronic Arts and the UNICEF Brazil country office partnered to create an "edutainment" video game development contest for university students in São Paulo: go.nmc.org/gqmbk.
- Researchers from the University of Campinas in Brazil, along with Purdue University, developed "3D Class," a game-based learning app for chemistry and life sciences: go.nmc.org/szvqg.

For Further Reading

Gamification & Latin American Education

go.nmc.org/laedu

(Frederico de Azevedo Aranha, *IDG Connect*, 27 August 2014.) The author describes the political and industrial factors that are creating a favourable climate for gamified education in Latin America.

A Systematic Mapping on Gamification Applied to Education (PDF)

go.nmc.org/sacom

(Simone de Sousa Borges et al., Symposium on Applied Computing, 2014.) A team of researchers from Brazilian universities carried out a mapping study to understand the breadth of research that has been performed about the gamification of education.

Time-to-Adoption: One Year or Less

Mobile Apps

There is a revolution that is taking place in software development that parallels the changes in recent years in the music, publishing, and retail industries. Mass market is giving way to niche market, and with it, the era of highly priced large suites of integrated software has shifted to a new view of what software should be. Smartphones such as the Galaxy, iPhone, and Android have redefined what we mean by mobile computing, and the small, often simple, low-cost software extensions to these devices — apps — have become a hotbed of development. A popular app can see millions of downloads in a very short time, and that potential market has spawned a flood of creativity that is instantly apparent in the extensive collections available in the app stores. These retail phenomena provide an easy, fast, and totally new way to deliver software that reduces distribution and marketing costs significantly. Apple's app store opened in July 2008; Google's followed in October of that year. Statista reports that as of June 2014, 75 billion apps had been downloaded in the Apple store and InformIT revealed that Google Play surpassed 80 billion. In the first quarter of 2014, Brazil was the second largest market for app downloads from the Google Play store, according to App Annie. Mobile apps are particularly useful for learning as they enable people to learn and experience new concepts wherever they are, often across multiple devices.

Relevance for Teaching, Learning, or Creative Inquiry

- Advancements in mobile software offer sophisticated tools that crunch numbers, create 3D images, and record environmental observations, which makes conducting scientific experiments from anywhere easier for students.
- As one-to-one and BYOD initiatives are implemented in more universities, administrators, instructors, and students are using productivity apps such as Evernote, Dropbox, and Google Drive to organize information and collaborate on projects.
- Mobile apps are replacing worksheets, as there are now apps that offer interactive exercises, games, and activities of every kind across disciplines, including the creative arts.

Mobile Apps in Practice

- The Brazilian government launched a competition called INOVApps aimed at fostering development and funding applications for serious games that focus on health, education, open policy making, and more: go.nmc.org/developers.
- Four female undergraduate students in computer science and computer engineering at the Institute of Computing of the Federal University of Amazonas developed a mobile app aimed at keeping women physically fit during pregnancy: go.nmc.org/fem.
- The Smithsonian created an iOS app for an exhibit featuring the collaborative art between Henrique Oliveira of Brazil and Sandile Zulu of South Africa, inviting users to virtually experiment with the artists' techniques: go.nmc.org/dialo.

For Further Reading

7 Apps to Help You in Your Studies. Before, During and After
go.nmc.org/list

(MobiFeed, 24 July 2014.) This list is broken up into three different stages of learning to explain how various apps can benefit students before, during, and even after their studies.

Free Educational Apps for Mobile Learning
go.nmc.org/apl

(Rafaela da Silva Melo and Breno Gonçalves Bragatti Neves, *Educational Technology Brazil*, July 2014.) The authors identify useful learning apps for Brazilian educators from the project F-Droid created by a group of British developers of the FOSS community (Free and Open Source Software) who ensure user privacy with their apps by not capturing users' personal data, nor exhibiting any advertising.

Time-to-Adoption: One Year or Less

Online Learning

Online learning is not new; the category encompasses any learning that takes place through web-based platforms, whether formal or informal. The learning can be structured as in traditional courses or entirely self-paced. What has made the topic new is the recent and unprecedented focus on providing learning via the Internet that has been stimulated by the tremendous interest in massive open online courses (MOOCs). Online learning has now “come of age;” the design of online learning is (more and more) specifically intended to encompass the latest research, the most promising developments, and new emerging business models in the online learning environment. At many institutions, online learning is an area newly ripe for experimentation — some would argue it is undergoing a sea change, with every dimension of the process open for reconceptualization. On campuses in Brazil, virtually every aspect of how students connect with institutions and each other to learn online is being reworked, rethought, and redone. There is still a need for online learning methods to be validated by research and solidified with strong Internet connectivity in order to be implemented as broadly as possible across the country.

Relevance for Teaching, Learning, or Creative Inquiry

- As new pedagogies emphasize personalized learning, there is a growing demand for learner-centered online opportunities. Online learning environments, when designed effectively, have the potential to scale globally.
- Online learning makes creative use of educational technologies and emerging instructional approaches, including blended learning, video lectures, and badges.
- When placed online, a diverse set of learning resources is easily accessible to students and can support self-directed learning.

Online Learning in Practice

- Pontifícia Universidade Católica do Rio Grande do Sul partnered with MiríadaX platform, the first MOOC in the Spanish and Portuguese speaking world: go.nmc.org/pucrs.
- Saraiva Prepara is an online course platform that prepares students for civil-service examinations and careers such as criminal and labor practice: go.nmc.org/saraiva.
- The State Secretariat of Science, Technology and Higher Education is working with Veduca to offer online courses at the Universidade Aberta e Integrada de Minas Gerais: go.nmc.org/veduca.

For Further Reading

Brazil: Can Traditional Distance Learning Become a Fertile Soil to Widen MOOCs?

go.nmc.org/hisdis

(Swissnex Brazil, 21 August 2014.) Distance education in Brazil has been in existence since 1904 because a number of states have low population density. This post discusses the recent exponential growth in distance learning brought on by the rise of MOOCs.

Brazilians Collect Diplomas in MOOC

go.nmc.org/brdiplo

(Vinicius de Oliveira, *Porvir*, 15 August 2014.) Brazilians are flocking to MOOCs for both degrees and professional development. This post discusses the online learning providers Veduca and Coursera, and ranks the popularity of their top courses in Brazil.

Distance Education: An Excuse Less for Those Who Want to Study

go.nmc.org/ucbbr

(Universidade Católica de Brasília, 5 June 2014.) The director of online courses at Catholic University of Brasília discusses the rise of distance learning. Students have been enjoying the benefits, including time flexibility and the ability to study anywhere.

Time-to-Adoption: Two to Three Years

Learning Analytics

Learning analytics is an educational application of web analytics, a science that is commonly used by businesses to analyze commercial activities, identify spending trends, and predict consumer behavior. Education is embarking on a similar pursuit into data science with the aim of learner profiling, a process of gathering and analyzing large amounts of detail about individual student interactions in online learning activities. The goal is to build better pedagogies, empower students to take an active part in their learning, target at-risk student populations, and assess factors affecting completion and student success. For learners, educators, and researchers, learning analytics is already starting to provide crucial insights into student progress and interaction with online texts, courseware, and learning environments used to deliver instruction. Students are beginning to experience the benefits of learning analytics as they engage with mobile and online platforms that track data to create responsive, personalized learning experiences.

Relevance for Teaching, Learning, or Creative Inquiry

- If used effectively, learning analytics helps surface early signals that indicate a student is struggling, allowing teachers and schools to address issues quickly.
- The science behind learning analytics in online environments can be used to create adaptive software that caters to a student's individual learning curve in real-time.
- When correctly applied and interpreted, learning analytics enables teachers to more precisely identify students' learning needs and tailor instruction appropriately.

Learning Analytics in Practice

- Guaxy is an adaptive web application that is being used in universities in São Paulo. It collects data showing student performance so that the system provides remediating material when concepts are not fully understood: go.nmc.org/guaxy.
- Researchers from the Institute of Computing at the Federal University of Alagoas created a predictive model that recommends video lectures for students according to their needs: go.nmc.org/edmpos.
- Scientists at the Laboratory of Computer Networks and Architecture at Universidade de São Paulo list their research goals for real-time big data analysis in this PDF proposal: go.nmc.org/larcsao.

For Further Reading

Learning to Adapt: A Case for Accelerating Adaptive Learning in Higher Education (PDF)

go.nmc.org/case

(Adam Newman et al., *Education Growth Advisors*, 13 March 2013.) A white paper funded by the Bill and Melinda Gates Foundation illustrates the current adoption of adaptive learning technologies in higher education, relevant obstacles, and potential solutions.

Supporting and Promoting Analytics Research

go.nmc.org/jalsiem

(George Siemens, *The Journal of Learning Analytics*, 2014.) In this article, Siemens provides an overview of the main activities for the development of the emerging field of learning analytics, which is led by the Society for Learning Analytics Research.

Understanding Education Through Big Data

go.nmc.org/underst

(Lyndsay Grant, *DML Central*, 25 October 2013.) This overview of big data describes how data mined from student activity is applied to generate a learner profile, used by institutions to tailor content to learners' strengths and interests.

Time-to-Adoption: Two to Three Years

Mobile Learning

We are in the midst of a complete shift in the devices we use. As smartphones and tablets become more and more capable and user interfaces more and more natural, old methods of computing seem place-bound and much less intuitive. People increasingly expect to be connected to the Internet and the rich tapestry of knowledge it contains wherever they go, and the majority of them use a mobile device to do so. According to Budde Comm, Brazilian residents account for one third of all mobile users in Latin America and the Caribbean, where mobile penetration is growing around 7% annually. The unprecedented evolution of these devices and the apps that run on them has opened the door to myriad uses for education. Learning institutions in Brazil are adopting apps into their curricula and modifying websites, educational materials, resources, and tools so they are optimized for mobile devices. The significance for teaching and learning is that these devices have the potential to facilitate almost any educational experience, allowing learners to organize virtual video meetings with peers all over the world, use specialized software and tools, and collaborate on shared documents or projects in the cloud, among many other things. Although there are still likely many uses that have not been realized yet, over the past several years mobile learning has moved quickly from concept to reality.

Relevance for Teaching, Learning, or Creative Inquiry

- As a one-to-one solution, mobiles present an economic, flexible alternative to laptops and desktops due to the devices' lower cost, greater portability, and access to apps.
- Mobile apps with built-in social features enable learners to share their questions or findings with each other in real-time. For example, productivity apps such as Evernote and Dropbox make it possible to exchange notes, assignments, and media.
- Students can leverage the cameras, microphones, and other tools inherent in mobiles to do field work or create rich media. This is especially convenient for work done outside of the classroom as students record interviews, collect data for experiments, and more.

Mobile Learning in Practice

- Because of a National Broadband Plan, the coverage of mobile broadband in Brazil has grown by 400% across the country since 2010, reaching 3,406 cities. This has been an essential precursor in progressing mobile learning across the country: go.nmc.org/mov.
- Researchers from the State University of Campinas developed a theoretical model to guide the production of educational micro-content for use in virtual learning environments: go.nmc.org/microbr.
- Universidade de São Paulo created an intelligent and adaptive e-learning tool called AdaptMLearning that can be used in mobile learning environments: go.nmc.org/sist.

For Further Reading

Challenges of Mobility for University Professors
go.nmc.org/mobilid

(Pavlos Dias, *Porvir*, 22 July 2014.) Mobile devices are helping facilitate lessons where videos, podcasts, concept maps, and debates in web forums can be accessed and created anywhere and any time.

The Future of Mobile Learning: Implications for Planners and Policymakers (PDF)
go.nmc.org/futmob

(Brasilia: UNESCO, 2014.) This publication presents an overview of the current status of mobile learning, describing recent developments in formal and informal education, innovative learning, and educational technology. It also highlights the issues that will impact mobile learning over the next 15 years.

Time-to-Adoption: Two to Three Years

Open Content

The movement toward open content and open educational resources (OER) reflects a growing shift in the way scholars in many parts of the world are conceptualizing education to a view that is more about the process of learning than the information conveyed. Information is everywhere; the challenge is to make effective use of it. Open content uses open licensing schemes, like those of Creative Commons, to encourage not only the sharing of information, but the sharing of pedagogies and experiences as well. Part of the appeal of open content is that it is a response to both the rising costs of traditionally published resources and the lack of educational resources in some regions. As this open, customizable content — and insights about how to teach and learn with it — is increasingly made available for free over the Internet, people are learning not only the material, but also the skills related to finding, evaluating, interpreting, and repurposing the resources. Recent data from Edcetera indicate that open educational resources make up three quarters of the content in most MOOCs; paid content, such as required textbooks, is less than 10%. These data reflect a notable transformation in the culture surrounding open content that will continue to impact how we think about content production, sharing, and learning. In their report, *Open Educational Resources in Brazil*, UNESCO points to several key international collaborations, including UNICAMP OpenCourseWare and the International Database of Educational Objects, as catalysts for Brazil's movement toward open content.

Relevance for Teaching, Learning, or Creative Inquiry

- In many cases, open materials can be easily updated and reposted to reflect the latest knowledge and discoveries.
- Many of Brazil's top institutions are proponents and users of open content and have made a wealth of materials available on demand to anyone.
- The use of open content promotes a set of skills that are critical in maintaining currency in any area of study — the ability to find, evaluate, and put new information to use.

Open Content in Practice

- The Hewlett Foundation recently funded a project led by Open Knowledge Brazil that will map and study OER initiatives in 24 countries throughout Latin America: go.nmc.org/openbr.
- The OER-Brazil Project, also known as Recursos Educacionais Abertos, provides media and information about OER and current government bills that promote it: go.nmc.org/broer.
- Teachers in training at Brazilian universities have access to a federal resource, Portal do Professor, that contains lesson plans and multimedia for curriculum that can be freely used and shared: go.nmc.org/portal.

For Further Reading

The Added Value in Open Educational Resources
go.nmc.org/inamorato

(Inamorato Andreia Santos, *Revista Digital de Tecnologias Cognitivas*, July 2013.) The author argues that while open education is gaining more attention in higher education institutions in Brazil, there are a number of issues that have yet to be addressed, including the return on investment for social and intellectual contributions.

The Complexity of Open Education: The Case of Brazil
go.nmc.org/cmplxbr

(Fabio Nascimbeni et al., MENON Network, 2014.) An open education expert describes the shift toward the use of OER and open education practices in higher education, emphasizing its uptake in Brazil.

Time-to-Adoption: Two to Three Years**Virtual and Remote Laboratories**

Virtual and remote laboratories reflect a movement among education institutions to make the equipment and elements of a physical science laboratory more easily available to learners from any location, via the web. Virtual laboratories are web applications that emulate the operation of real laboratories and enable students to practice in a “safe” environment before using real, physical components. Students can typically access virtual labs 24/7, from wherever they are, and run the same experiments over and over again. Some emerging virtual lab platforms also incorporate reporting templates that populate with the results of the experiments so that students and teachers can easily review the outcomes. Remote laboratories, on the other hand, provide a virtual interface to a real, physical laboratory. Institutions that do not have access to high-caliber lab equipment run experiments and perform lab work online, accessing the tools from a central location. Users are able to manipulate the equipment and watch the activities unfold via a webcam on a computer or mobile device. This provides students with a realistic view of system behavior and allows them access to professional laboratory tools from anywhere, whenever they need. Additionally, remote labs alleviate some financial burden for Brazilian institutions as they can forgo purchasing specific equipment and use the remote tools that are at their disposal.

Relevance for Teaching, Learning, or Creative Inquiry

- Because virtual laboratories do not involve real equipment or chemicals, students feel more comfortable making mistakes and run experiments in complete safety.
- Instructors play back videos of the experiments students have run online, pinpoint areas for improvement or further discussion, and acknowledge students who have excelled.
- Virtual and remote labs increase access to science tools, allowing learners to use them via wireless or cellular networks. This is particularly useful for online or hybrid learning programs in which students cannot always be present on campus.

Virtual and Remote Laboratories in Practice

- At the Department of Computer Engineering, University of Coimbra, the remote and virtual laboratory offers interactive applications that allow users to conduct experiments using physical systems that are controlled remotely or locally: go.nmc.org/coi.
- In collaboration with the School of Basic Education Maria Garcia Pessi, the Remote Laboratory Experimentation at Federal University of Santa Catarina is using Moodle to allow users to access remote tools from their mobile devices: go.nmc.org/access.
- The Open Science Laboratory hosts investigations that leverage on-screen instruments, remote access experiments, and virtual scenarios using real data: go.nmc.org/opensci.

For Further Reading

Education online: The Virtual Lab

go.nmc.org/edon

(M. Mitchell Waldrop, *Nature*, 17 July 2013.) Online video lectures are good at initially conveying facts, formulas and concepts, but they must incorporate ways for students to put the ideas into practice. This article describes examples of how universities are benefiting from incorporating virtual and remote labs and even virtual internships.

Bringing Remote Labs and Mobile Learning Together

go.nmc.org/bringing

(Dominik May et al., *IJIM*, May 2013.) This paper describes how remote laboratories for engineering can be linked with mobile devices and e-portfolios to create a unique learning environment, which documents each learner's personal learning process.

Time-to-Adoption: Four to Five Years

Augmented Reality

Augmented reality (AR), a capability that has been around for decades, has shifted from what was once seen as a gimmick to a tool with tremendous potential. The layering of information over 3D space produces a new experience of the world, sometimes referred to as “blended reality,” and is fueling the broader migration of computing from the desktop to the mobile device, bringing with it new expectations regarding access to information and new opportunities for learning. While the most prevalent uses of augmented reality so far have been in the consumer sector (for marketing, social engagement, amusement, or location-based information), new uses seem to emerge almost daily, as tools for creating new applications become even easier to use. A key characteristic of augmented reality is its ability to respond to user input, which confers significant potential for learning and assessment; with it, learners can construct new understanding based on interactions with virtual objects that bring underlying data to life. Dynamic processes, extensive datasets, and objects too large or too small to be manipulated are brought into a learner’s personal space at a scale and in a form easy to understand and work with.

Relevance for Teaching, Learning, or Creative Inquiry

- Augmented reality constructs provide contextual, in situ learning experiences that foster exploration of real world data in virtual surroundings and simulations.
- Games that are based in the real world and augmented with networked data give educators powerful new ways to show relationships and connections in computer science.
- Students doing outdoor fieldwork access AR applications to overlay maps and information about their surroundings, or to enter field observations and data that is automatically geocoded as the records are created.

Augmented Reality in Practice

- Brazilian researchers have designed a method of displaying volumetric data in a markerless augmented reality environment that will assist surgeons as they operate on patients: go.nmc.org/anatobr.
- Scientists at VOXAR Labs at the Informatics Center of the Federal University of Pernambuco are developing interactive AR applications for Google Glass: go.nmc.org/googar.
- University of Exeter created an augmented reality app that turned the campus into a living laboratory by overlaying biodiversity information over specific areas: go.nmc.org/exet.

For Further Reading

Effects of Mobile Augmented Reality Learning Compared to Textbook Learning on Medical Students: Randomized Controlled Pilot Study

go.nmc.org/emot

(Urs-Vito Albrecht et al, *The Journal of Medical Internet Research*, 20 August 2013.) This study shows how students that are learning with the aid of augmented reality experience more emotional involvement during the learning process compared to those using only textbooks.

Possibilities of Augmented Reality Use in Mathematics Aiming at a Meaningful Learning

go.nmc.org/possib

(Carlos Vitor de Alencar Carvalho and Bruno Morais Lemos, *Creative Education*, May 2014.) The authors discuss how visualization of mathematical objects using augmented reality software can allow students to better visualize concepts and test hypotheses.

Time-to-Adoption: Four to Five Years

The Internet of Things

The Internet of Things is a network of connected objects that link the physical world with the world of information through the web. The advent of TCP/IP v6, launched in 2006, expanded the capabilities of the Internet, and enabled objects, sensors, and devices to be addressable and thus findable across the Internet. This augmented address space is particularly useful for tracking objects that monitor sensitive equipment or materials, point-of-sale purchases, passport tracking, inventory management, identification, and similar applications. Embedded chips, sensors, or tiny processors attached to an object allow helpful information about the object, such as cost, age, temperature, color, pressure, or humidity to be transmitted over the Internet. This simple connection supports remote management, status monitoring, tracking, and alerts if the objects they are attached to are in danger of being damaged or spoiled. Many web tools enable objects to be annotated with descriptions, photographs, and connections to other objects, and other contextual information; the Internet of Things makes access to these data as easy as it is to use the web.

Relevance for Teaching, Learning, or Creative Inquiry

- Informal learning institutions, such as museums, are already leveraging the Internet of Things to track and monitor the conditions of ancient artefacts, such as individual dinosaur bones.
- The Internet of Things can be particularly useful in fieldwork, facilitating opportunities for students to collect scientific data through mobile devices and instantly add them to large databases.
- Internet of Things-enabled innovations such as the Nest Learning Thermostat allow owners to control the conditions of physical spaces through their smartphones in addition to self-programming.

The Internet of Things in Practice

- The Fórum de Competitividade de IoT coordinated a meeting that brought together Brazilian scientists and industry leaders to discuss IoT topics including benchmarking, interoperability, marketing, and development: go.nmc.org/itowork.
- The São Paulo research foundation Fapesp announced that they will allocate \$200,000 to fund Brazilian projects that focus on the development of secure, lightweight chips for the Internet of Things: go.nmc.org/fapesp.
- SouJava and Oracle Technology Network organized a week-long hackathon for developers, students, and gamers in Brazil to create IoT projects using Raspberry Pi and Java: go.nmc.org/javahack.

For Further Reading

Brazil Spotlights Innovations and the Internet of Everything

go.nmc.org/spotbr

(Rob Lloyd, Cisco Blog, 3 September 2013.) Cisco's executive sponsor for Brazil recalls the launch of the Rio Center of Innovation as the culmination of a series of investments made to promote the development of the Internet of Everything, citing the economic impact these new technologies will likely have over the next decade.

Thirty (Plus) Ways the Internet of Things is Changing the World

go.nmc.org/iotfuture

(Daniel Castro, *The Futurist*, 19 November 2013.) The author describes how the Internet of Things is offering solutions to major societal challenges such as energy conservation, agricultural productivity, affordable healthcare, and efficient modes of transportation.

Time-to-Adoption: Four to Five Years

Location Intelligence

Location intelligence refers to the mapping of the geographic relationships associated with data. Resources including GIS are used to provide individuals and organizations with information about how people are interacting with various applications and services based on their location. Through combinations of trilateration, WiFi fingerprinting, and crowdsourcing data, the data and patterns achieved through location intelligence are extremely accurate. Smartphones and tablets are naturally driving the proliferation of this technology because of their built-in location-sensitive sensors, WiFi signals, gyroscopes, magnetometers and accelerometers, and other features. Major players in the mobile and wearable technology space, such as Apple and Google, are rapidly acquiring the latest location intelligence technologies with the goal of enhancing the ways in which consumers interact with their surroundings. Apple recently purchased Locationary, a start-up that leverages crowdsourcing and game mechanics to update a database of location information for businesses. Additionally, they acquired WiFiSLAM, a company that specializes in employing WiFi signals, GPS, and sensors to track user movements within buildings. WiFiSLAM uses pattern recognition and machine learning to detect relationships between the data collected through all of the sensors in a device to create reliable indoor maps. Ultimately, location intelligence is poised to help people better understand their environments and even contribute their own measurements in an effort to map the entire world, inside and out.

Relevance for Teaching, Learning, or Creative Inquiry

- Effective for both on and off-campus projects, location-based services enable immersive activities including collective mapping, scavenger hunts, and scientific data collection.
- For informal learning, location-based services can help museum patrons more easily find specific exhibits and artworks in a large gallery space, and in some cases, make recommendations for other places in the museum to visit, based on their preferences.
- Mobile apps offering location-based services (e.g. Nru and Wikitude) provide people with information about historic and cultural sites.

Location Intelligence in Practice

- An agreement between University Vila Velha and Espirito Santo Research Institute allows students and faculty access to the Geospatial Bases of the State of Espírito Santo by the University for location intelligence research: go.nmc.org/gisbr.
- Developed by a Unicamp researcher, location software for robotic equipment is being adapted for wheelchair patients that have neurological traumas: go.nmc.org/intelamp.
- The MundoGEOXperience event in São Paulo featured the integration, competition, and development of innovative projects using location intelligence: go.nmc.org/mundo.

For Further Reading

Smartphones and Location Awareness in Brazil: Users' Reactions
go.nmc.org/smarlo

(Ribeirão Preto, *Paidéia*, January 2014) This study explored how Brazilians are using the many features of their smartphones according to their own accounts. Of particular interest were the ways in which they react to location intelligence.

The World Soccer Match: Where Social-Mobile-Local Could Really Shine
go.nmc.org/socc

(Lorena Hathaway, Pitney Bowes, 4 June 2014.) Location intelligence is an extremely powerful source of predictive data. When layered across GIS platforms and then applied to current information from streaming mobile and social data, universities can explore what happened and then plan for the future.

Time-to-Adoption: Four to Five Years

Virtual Assistants

As voice recognition and gesture-based technologies advance and more recently, converge, people are quickly moving away from the notion of interacting with their devices via a pointer and keyboard. Virtual assistants are a credible extension of work being done with natural user interfaces, and the first examples are already in the marketplace. The concept builds on developments in interfaces across the spectrum of engineering, computer science, and biometrics. The Apple iPhone's Siri and Android's Jelly Bean are recent mobile-based examples, and allow users to control all the functions of the phone, participate in lifelike conversations with the virtual assistant, and more. A new class of smart televisions are among the first devices to make comprehensive use of the idea. While crude versions of virtual assistants have been around for some time, they have yet to achieve the level of interactivity seen in Apple's classic video, Knowledge Navigator. Virtual assistants of that caliber and their applications for learning are clearly farther out in Brazilian higher education institutions as well as universities all over the globe, but the potential of the technology to add substance to informal modes of learning is compelling.

Relevance for Teaching, Learning, or Creative Inquiry

- Accessible through natural user interfaces, virtual assistants can be designed specifically to aid blind, deaf, and otherwise disabled learners.
- Over time, virtual assistants can potentially function as real-time translators, increasing the scope and depth of collaboration between institutions globally.
- Virtual assistants access information from email accounts, personal calendars, and LMS to help students and faculty better manage their time and coordinate their work.

Virtual Assistants in Practice

- Brazilian university group Estácio partnered with Artificial Solutions to use its natural language interaction platform as they implement plans to design an online virtual assistant: go.nmc.org/estacio.
- MIT Media Lab plans to commercialize BlabDroid, a virtual assistant that connects to a smartphone, so it can communicate pertinent information to users, including the weather, and post to a social network based on voice commands: go.nmc.org/blab.
- The University of Lleida is developing a robotic personal assistant that will enable professionals who work from home to have a virtual and mobile presence in meetings and informal gatherings. This has implications for distance students: go.nmc.org/lle.

For Further Reading

Bill Gates: Virtual Assistants Can Save the World

go.nmc.org/billg

(Tom Simonite, *MIT Technology Review*, 16 July 2013.) At a recent conference, Bill Gates described how intelligent software will soon leverage user data to adapt and respond to that user, which will benefit learning in both virtual and face-to-face classes as well as other industries like mobile banking.

Virtual Assistants Simplify the Promise of Life Members

go.nmc.org/promet

(Ana Clara Nogueira, *PSafe Blog*, 11 June 2014.) This article compares the voice command function of several virtual assistants currently on the market: Google Now, Siri, and Cortona. Google Now is the first to have a Portuguese version.

Key Trends Accelerating Technology Adoption

The technologies featured in the NMC Horizon Project are embedded within a contemporary context that reflects the realities of the time, both in the sphere of education and in the world at large. To assure this perspective, each panel member researches, identifies, and ranks key trends that are currently affecting teaching, learning, and creative inquiry in Brazilian higher education, and uses these as a lens for the panel's work in predicting the uptake of emerging technologies.

These nine trends, which the expert panel agreed are very likely to drive technology planning and decision-making over the next five years, are sorted into three time-related categories — fast-moving trends that will realize their impact in the next one to two years, and two categories of slower trends that will realize their impact within three to five (or more) years.

Fast Trends

Driving Ed Tech adoption in Brazilian universities over the next one to two years

Evolution of Online Learning. Over the past several years, there has been a shift in the perception of online learning to the point where it is seen as a viable alternative to some forms of face-to-face learning. The value that online learning offers is now well understood, with flexibility, ease of access, and the integration of sophisticated multimedia and technologies chief among the list of appeals. Recent developments in business models are upping the ante of innovation in these digital environments, which are now widely considered to be ripe for new ideas, services, and products. Progress in learning analytics, adaptive learning, and a combination of cutting-edge asynchronous and synchronous tools will continue to advance the state of online learning and keep it compelling.

Increasing Use of Hybrid Learning Designs. Students already spend much of their free time on the Internet, learning and exchanging new information. Institutions that embrace face-to-face, online, and hybrid learning models have the potential to leverage the online skills learners have already developed independent of academia. Online learning environments can offer different affordances than physical campuses, including opportunities for increased collaboration while equipping students with stronger digital skills. Hybrid models enable students to travel to campus for some activities, while using the network for others, taking advantage of the best of both environments.

Rethinking the Roles of Educators. Instructors are increasingly expected to be adept at a variety of technology-based and other approaches for content delivery, learner support, and assessment; to collaborate with other teachers both inside and outside their schools; to routinely use digital strategies in their work with students; and to organize their own work and comply with administrative documentation and reporting requirements. The integration of technology into everyday life is causing many educational thought leaders to reimagine the way subjects and lessons are taught, with an emphasis on acting as guides and mentors to promote independent and active learning.

Mid-Range Trends

Driving Ed Tech adoption in Brazilian universities over the next three to five years

Digital Delivery is Increasingly the Norm. Digital delivery will one day be the norm, resulting in less face-to-face interaction. The open source movement has yielded thousands of online educational resources and a growing number of educational entrepreneurs and startups whose primary role is to create and deliver digital content. With the rise of free services including TED talks, Wikipedia, the Khan Academy, and many others, higher education continues to experience a paradigm shift in which online learning represents the intersection

of formal and informal learning. MOOCs, for example, can be taken for credit or purely for new skill acquisition or curiosity sake. More and more, faculty in Brazil are interacting with students through online discussion forums and by sharing video and audio recordings.

Growing Ubiquity of Social Media. Social media are changing the way people interact, present ideas and information, and judge the quality of content and contributions. According to Social Media Today, the total online audience in Brazil was 46 million people, with an astounding 97% active on social media. Last year, the time spent on Facebook alone by Brazilian residents increased by 208% per month. Educators, students, alumni, and the general public routinely use social media to share news about scientific and other developments. The impact of these changes in scholarly communication and on the credibility of information remains to be seen, but it is clear that social media has found traction in Brazilian education.

Shift from Students as Consumers to Students as Creators. A shift is taking place in the focus of pedagogical practice on university campuses as students across a variety of disciplines are learning by making and creating rather than from the simple consumption of content. Creativity, as illustrated by the growth of user-generated videos, maker communities, and crowd-funded projects in the past couple years, is increasingly the means for active learning. University departments in areas that have not traditionally had lab or hands-on components are shifting to incorporate hands-on learning experiences as an integral part of the curriculum. Courses and degree plans in Brazilian institutions for many disciplines are in the process of changing to reflect the importance of media creation, design, and entrepreneurship.

Long-Range Trends

Driving Ed Tech adoption in Brazilian universities over the next five or more years

Agile Approaches to Change. There is a growing consensus among many higher education thought leaders that institutional leadership and curricula could benefit from agile startup models. Educators are working to develop new approaches and programs based on these models that stimulate top-down change and can be implemented across a broad range of institutional settings. The Lean Startup movement uses technology as a catalyst for promoting a culture of innovation in a more widespread, cost-effective manner. Pilots and other experimental programs across Brazil are being considered for teaching and improving organizational structure to more effectively nurture entrepreneurship.

Massive Reinvention of the Personal Computer. The computer is smaller, lighter, and better connected than ever before, without the need for wires or bulky peripherals. In many cases, smartphones and other mobile devices are sufficient for basic computing needs, and only specialized tasks require a keyboard, large monitor, and a mouse. Mobiles are connected to an ecosystem of applications supported by cloud computing technologies that are downloaded and used instantly, for pennies. As the capabilities and interfaces of small computing devices improve, our ideas about when — or whether — a traditional computer is necessary are changing as well.

New Forms of Multidisciplinary Research. Digital humanities and computational social science research approaches are opening up new pioneering areas of multidisciplinary research, innovative forms of scholarship and publication, and new kinds of courses and pedagogies. Researchers, along with academic technologists and developers, are breaking new ground with data structures, visualization, geospatial applications, and innovative uses of open source tools. At the same time, they are pioneering new forms of scholarly publication that combine traditional static print style scholarship with dynamic and interactive tools, which enables real-time manipulation of research data.

Significant Challenges Impeding Technology Adoption

Along with the trends discussed in the preceding section, the expert panel noted a number of significant challenges faced in Brazilian universities that are impeding the uptake of emerging technologies. Because not all challenges are of the same scope, the discussions here are sorted into three categories defined by the nature of the challenge. The NMC Horizon Project defines solvable challenges as those that we both understand and know how to solve; difficult challenges are ones that are more or less well understood, but for which solutions remain elusive. Wicked challenges, the most difficult, are categorized as complex to even define, and thus require additional data and insights before solutions will even be possible.

Solvable Challenges

Those which we both understand and know how to solve

Expanding Access. The global drive to increase the number of students participating in undergraduate education is placing pressure across the system. The oft-cited relationship between earning potential and educational attainment plus the clear impact of an educated society on the growth of the middle class is pushing governments to encourage more and more students to enter universities and colleges. In many countries, however, the population of students prepared for undergraduate study is already enrolled — expanding access means extending it to students who may not have the academic background to be successful without additional support. Many in universities feel that these institutions do not have sufficient time and resources to help this set of students.

Rethinking the Role of Vocational Education. Many jobs call for specialization in very specific and often technical fields, prompting people to skip higher education and move directly into apprenticeships, or to enroll in one- or two-year vocational programs. There is a need for vocational education to be made more accessible, and to be better integrated into traditional university settings. Vocational training often involves hands-on opportunities; for example, aspiring electricians often work on practice devices and assist seasoned electricians out in the field. This type of immersive experience can be applied to many disciplines in higher education. While MOOCs are enabling people to receive training on specific subjects such as computer programming at their own pace, from wherever they are, vocational education experiences are not yet prevalent online.

Scaling Teaching Innovations. Brazilian universities are not adept at moving teaching innovations into mainstream practice. Innovation springs from the freedom to connect ideas in new ways. Schools and universities generally allow students to connect ideas only in prescribed ways — sometimes these lead to new insights, but more likely they lead to rote learning. Current organizational promotion structures rarely reward innovation and improvements in teaching and learning. A pervasive aversion to change limits the diffusion of new ideas, and too often discourages experimentation.

Difficult Challenges

Those we understand but for which solutions are elusive

Complex Thinking and Communication. In order to be successful in the 21st century, one needs to be capable not only of complex, expert thinking, but also adept at communicating complex information in accessible, understandable ways. Today's young people live in a world that is interconnected in myriad ways, and they begin to engage with social media and networks at a very early age. Institutions have the responsibility of informing learners of how to understand relationships and make decisions in that interconnected world. The semantic web, big data, modeling technologies, and other innovations are creating the experimental

conditions that have the potential to train learners in complex and systems thinking to create meaningful learning experiences.

Creating Authentic Learning Opportunities. Learning that incorporates real life experiences is not occurring enough and is undervalued when it does take place. This challenge is an important one in schools because it can greatly impact the engagement of students who are seeking some connection between the world as they know it exists outside of class, and their experiences in school that are meant to prepare them for that world. Use of project-based learning practices that incorporate real life experiences, technology and tools that are already familiar to students, and mentoring from community members are examples of approaches that can bring the real world into the classroom. Practices such as these in Brazil may help retain students in university and prepare them for further education, careers, and citizenship in a way that traditional practices are failing to do.

Reducing the Technology Gap Between Faculty and Students. In the past 20 years, technologies have advanced very quickly. While the latest generation of students has grown up with mobile devices, wearables, and social networks, many faculty do not have the same level of familiarity. Despite the widespread agreement on the importance of digital media literacy, training in the supporting skills and techniques is rare in teacher education and almost non-existent in the preparation of faculty in Brazil. As lecturers and professors begin to realize that they are limiting their students by not helping them to develop and use digital media literacy skills across the curriculum, the lack of formal training is being offset through professional development or informal learning.

Wicked Challenges

Those that are complex to even define, much less address

Competition from New Models of Education. New models of education are bringing unprecedented competition to the traditional models of education. Institutions are looking for ways to provide a high quality of service and more learning opportunities. Massive open online courses are at the forefront of these discussions, enabling students to supplement their education and experiences at brick-and-mortar institutions with increasingly rich, and often free, online offerings. At the same time, issues have arisen related to the low completion rates of some MOOCs. As these new platforms emerge, there is a growing need to frankly evaluate the models and determine how to best support collaboration, interaction, and assessment at scale. Simply capitalizing on new technology is not enough; the new models must use these tools and services to engage students on a deeper level.

Keeping Education Relevant. Many pundits worry that if education does not adapt to the times, other models of learning (especially other business models) will take its place. While this concern has some merits, it is unlikely that schools as we know them will go away. As online learning and free educational content become more pervasive, institutional stakeholders must address the question of what school can provide that other approaches cannot, and rethink the value of education from a student's perspective.

Relative Lack of Rewards for Teaching. Teaching is often rated lower than research in academia. In the national education marketplace, a university's status is largely determined on the quantity and quality of its research. There is an overarching sense in the academic world that research credentials are a more valuable asset than talent and skill as an instructor. Because of this way of thinking, efforts to implement effective pedagogies are lacking. To balance competing priorities, larger universities are experimenting with alternating heavy and light teaching loads throughout the school year, and hiring more part-time faculty.

Methodology

The process used to research and create the *2014 NMC Technology Outlook for Brazilian Universities: A Horizon Project Regional Report* is very much rooted in the methods used throughout the NMC Horizon Project. All publications of the NMC Horizon Project are produced using a carefully constructed process that is informed by both primary and secondary research. Dozens of technologies, meaningful trends, and critical challenges are examined for possible inclusion in the report for each edition. Every report draws on the considerable expertise of an internationally renowned panel of experts that first considers a broad set of important emerging technologies, challenges, and trends, and then examines each of them in progressively more detail, reducing the set until the final listing of technologies, trends, and challenges is selected.

Much of the process takes place online, where it is captured and placed in the NMC Horizon Project wiki. This wiki, which has grown into a resource of hundreds of pages, is intended to be a completely transparent window onto the work of the project, and contains the entire record of the research for each of the various editions. The section of the wiki used for the *2014 NMC Technology Outlook for Brazilian Universities* can be found at brasil.wiki.nmc.org.

The procedures for selecting the topics that are in this report include a modified Delphi process now refined over years of producing the *NMC Horizon Report* series, and it began with the assembly of the expert panel. The panel as a whole was intended to represent a wide range of backgrounds and interests, yet with each member bringing a particularly relevant expertise. To date, hundreds of internationally recognized practitioners and thought leaders have participated in the NMC Horizon Project Expert Panel; in any given year, a third of the experts are new, ensuring a flow of fresh perspectives each year.

Once the expert panel for a particular edition is constituted, their work begins with a systematic review of the literature — press clippings, reports, essays, and other materials — that pertains to emerging technology. Panel members are provided with an extensive set of background materials when the project begins, and are then asked to comment on them, identify those that seem especially worthwhile, and add to the set. The group discusses existing applications of emerging technology and brainstorms new ones. A key criterion for the inclusion of a topic is the potential relevance of the topic to teaching, learning, or creative inquiry. A carefully selected set of RSS feeds from dozens of relevant publications ensures that background resources stay current as the project progresses. They are used to inform the thinking of the participants throughout the process.

Following the review of the literature, the expert panel engages in the central focus of the research — the research questions that are at the core of the NMC Horizon Project. These questions are designed to elicit a comprehensive listing of interesting technologies, challenges, and trends from the panel:

1. *Which of these key technologies will be most important to Brazilian universities within the next five years?*
2. *What key technologies are missing from our list? Consider these related questions:*
 - a. *What would you list among the established technologies that some Brazilian universities and educational programs are using today that arguably ALL institutions and programs should be using broadly to support or enhance teaching, learning, or creative inquiry?*
 - b. *What technologies that have a solid user base in consumer, entertainment, or other industries should Brazilian universities and educational programs be actively looking for ways to apply?*

- c. *What are the key emerging technologies you see developing to the point that Brazilian universities and educational programs should begin to take notice during the next four to five years?*
3. *What trends do you expect to have a significant impact on the ways in which Brazilian universities and educational programs approach our core missions of teaching, learning, and creative inquiry?*
4. *What do you see as the key challenges related to teaching, learning, and creative inquiry that Brazilian universities and educational programs will face during the next five years?*

One of the expert panel's most important tasks is to answer these questions as systematically and broadly as possible, so as to ensure that the range of relevant topics is considered. Once this work is done, a process that moves quickly over just a few days, the expert panel moves to a unique consensus-building process based on an iterative Delphi-based methodology.

The responses to the research questions are systematically ranked and placed into adoption horizons by each advisory board member using a multi-vote system that allows members to weight their selections. Each member is asked to also identify the timeframe during which they feel the technology would enter mainstream use — defined for the purpose of the project as about 20% of institutions adopting it within the period discussed. (This figure is based on the research of Geoffrey A. Moore and refers to the critical mass of adoptions needed for a technology to have a chance of entering broad use.) They also rank the degree and scope of each challenge as solvable, difficult, or wicked. These rankings are compiled into a collective set of responses, and inevitably, the ones around which there is the most agreement are quickly apparent.

For additional detail on the project methodology or to review the instrumentation, the ranking, and the interim products behind the report, please visit the project wiki, which can be found at brasil.wiki.nmc.org.



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