Building Organizational Capacity for Analytics

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About the Authors

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Introduction

Optimizing student success is the "killer app" for analytics in higher education. Intelligent investments in optimizing student success garner wide support and have a strong, justifiable return on investment (ROI). Moreover, improving performance, productivity, and institutional effectiveness is the new gold standard for institutional leadership in the 21st century. Enhanced analytics is critical to both optimizing student success and achieving institutional effectiveness.

This report provides information about how leading institutions in higher education and vendors are building capacity in analytics to improve student success. The initial stage of this project was a survey of institutional practitioners and vendors to determine the state of practice and gaps between needs and solutions. We relied on a sampling of 40 leading institutions (recommended by practitioners and thought leaders in the field) to determine the sorts of analytics innovations and practices that are possible with current and emerging tools. Our sampling of leading solution providers offered insights into the changing strategies and toolsets offered. These companies also provided candid feedback on the state of analytics readiness of typical institutions they were encountering in the marketplace.[1]

We conducted detailed interviews with 40 leading institutions that have developed analytics applications to support student success. These range across the spectrum of institutional categories in American higher education:

- for-profit universities and online, not-for-profit universities,
- research universities,
- comprehensive universities,
- private colleges and universities,
- community colleges, and
- systems of institutions (community and technical colleges and comprehensive universities).

Different patterns of organizational development in analytics are emerging for each of these groups of institutional leaders and will be shared as part of the analysis. Moreover, we intend to progressively extend the sample of institutions beyond the initial sample of 40.

In addition, 20 technology vendors were surveyed, including a sampling of

- business intelligence (BI) and enterprise resource planning (ERP) systems providers,
- learning management systems and related services providers,
- advising/retention services solution providers,
- visualization, dashboard, and analytics solutions providers,

[1] Strategic Initiatives, with support from the Tambellini Group, is undertaking a consulting services project to advance the development of organizational capacity for analytics in higher education. This project is funded by the Bill & Melinda Gates Foundation. The ultimate goal is optimizing student success through deployment and leveraging of advanced analytics practices. Optimizing student success occurs within the larger institutional context of improving performance, productivity, and institutional effectiveness.

- retention and student success applications providers and customer relationship management (CRM) system providers, and
- an emerging class of companies providing learner relationship management solutions.

We have assessed their range of tools, applications, solutions, and services; their visions, strategies, and roadmaps for their future; and their assessments of the challenges faced by institutions contemplating analytics solutions in today's higher education environment.

Over time, we plan to expand the survey of solution providers to include an additional 20 analytics solution providers that have emerged in the higher education marketplace over the past year. These will include several new categories: learner relationship management solutions and personalized learning environment solutions, which have analytics components. The number and nature of analytics-related solution providers are growing, and their offerings are becoming more comprehensive and sophisticated. We intend to continue to extend the solution provider surveys to include more providers as the analytics field continues to expand in early 2013.

This preliminary report is an overview of the findings from an initial, high-level analysis of the results. The surveys describe the state of the industry and the current and future nature of the analytics gap in higher education. We presented an overview of findings and engaged in discussion at EDUCAUSE 2011 in a concurrent session, "Bridging the Analytics Gap: Needs and Solutions"; in a plenary session at the LAK 12 Conference on Building Organizational Capacity in Analytics; and in a workshop and concurrent session at EDUCAUSE 2012.

These findings are the foundation for *A Toolkit for Building Organizational Capacity in Analytics*, currently being developed with funding from the Bill & Melinda Gates Foundation. We presented a full-day workshop at EDUCAUSE 2012, "Crafting an Action Plan/Strategy for Analytics at Your Campus." These action plans/strategies focus on creating plans/strategies, executing strategy, and building organizational capacity. Feedback from this workshop has been used to refine and focus the contents of the toolkit.

This paper provides overall findings, illustrated by a few examples, which will be progressively extended through the life of the project. We will be continuously updating our information on participating institutions and vendors.

What Is Analytics?

In *Analytics in Higher Education: Establishing a Common Language*, van Barneveld, Arnold, and Campbell explored the basic definitions of analytics in higher education.

> Today's society is driven by data, as evidenced by popular use of the term *analytics*. In some cases, the term may reflect specific topics of interest (health analytics, safety analytics, geospatial analytics), while in other cases, it may reflect the intent of the activity (descriptive analytics, predictive analytics, prescriptive analytics) or even the object of analysis (Twitter analytics, Facebook analytics, Google analytics). A variety of terms for analytics also exist in the educational domain. Higher education's approach to defining analytics is particularly inconsistent. Some definitions are conceptual (what it *is*), while others were more functional (what it *does*). Analytics is the process of data assessment and analysis that enables us to measure, improve, and compare the performance of individuals, programs, departments, institutions or enterprises, groups of organizations and/or entire industries."[2]

Figure 1 summarizes the distinction between *learning analytics* and *academic analytics* presented in this paper.

Learning and Academic Analytics

Type of Analytics	Level or Object of Analysis	Who Benefits?
Learning Analytics	**Course-level**: social networks, conceptual development, discourse analysis, "intelligent curriculum"	Learners, faculty
	Departmental: predictive modeling, patterns of success/ failure	Learners, faculty
Academic Analytics	**Institutional**: learner profiles, performance of academics, knowledge flow	Administrators, funders, marketing
	Regional (state/provincial): comparisons between systems	Funders, administrators
	National and International	National governments, education authorities

Source: Phil Long and George Siemens, "Penetrating the Fog: Analytics in Learning and Education," *EDUCAUSE Review* 46, no. 5 (September/October 2011), 34.

Figure 1. Learning and academic analytics

[2] Angela van Barneveld, Kimberly E. Arnold, and John P. Campbell, "Analytics in Higher Education: Establishing a Common Language," ELI Paper 1 (Boulder, CO: EDUCAUSE, 2012), 2, http://net.educause.edu/ir/library/pdf/ELI3026.pdf.

Taking these definitions a step further, we need to explore how the full range of data, reporting, query, and analytics is used in institutions to improve understanding and performance. Our definition of analytics includes the full range of data stewardship/governance, query, reporting, and analytics activities portrayed in the widely used framework developed by Davenport and Harris in their matrix on data, information, and analytics (business intelligence). These nine elements, their primary focus, and their decision making and action perspectives are portrayed in figure 2.

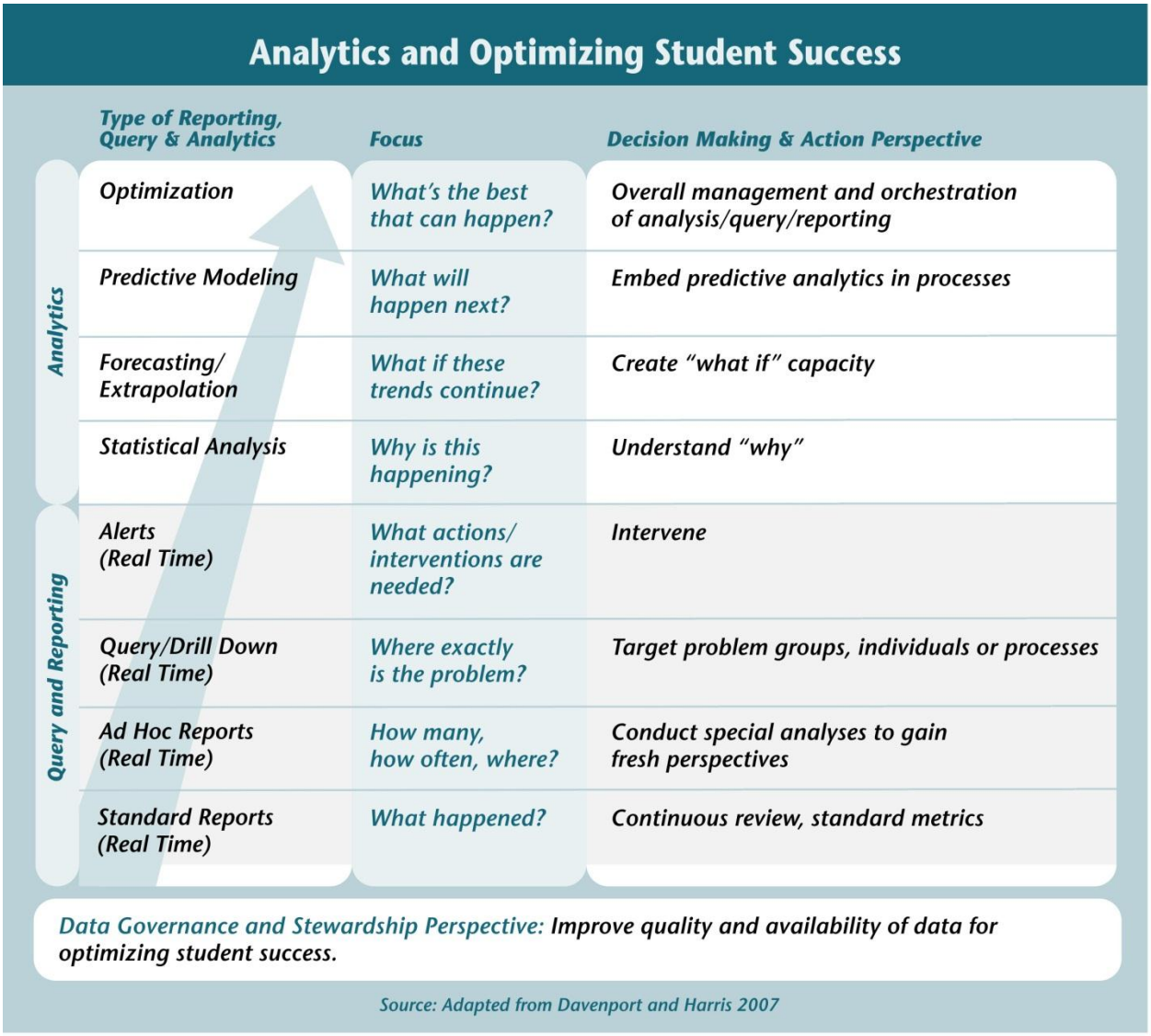

Figure 2. Analytics and optimizing student success

One should start at the bottom of this graphic and read toward the top. The underlying quality and availability of data relating to student performance and success is of paramount importance and requires active institutional attention. The bottom four levels deal with query and reporting. They are essential because they enable institutions to operate with real-time data—to understand what is happening, drill down to where the problem is, and intervene to improve

performance. The top four analytics layers enable institutions to understand why things happen, project current trends, predict the impacts of current events, and orchestrate all of these elements together to optimize outcomes—in our case, focus on student success.

Davenport's framework suggests that value increases for an enterprise as one moves up the typology toward optimization. While this is true, the applications of these tools and practices in support of optimizing student success (and productivity and institutional effectiveness) require well-developed combinations of all nine levels of data stewardship, reporting, query, and analytics tools portrayed in the framework.

These combinations are deployed at the same time and in support of each other. Institutions cannot achieve optimization of student success unless they master and leverage all of the vectors of data, reporting, query, and analysis. Even advanced institutional practitioners have not yet tapped their full potential.

Moreover, the student success initiatives we have studied are extracting and analyzing data from the broad range of data systems available to higher education enterprises. These include:

- ERP systems (student, finance, financial aid, human resources, advancement, and other modules to be added over time)
- Third-party administrative systems (co-curricular systems, parking, residence hall, food service, bookstore, other auxiliary enterprises)
- Academic enterprise systems (LMS, other personalized learning systems, library, academic support services)
- Assessment (testing, student evaluation, course and faculty evaluation, NSSE/CSSE)
- Customer relationship management systems and/or CRM functionality in other systems
- Peer institution and benchmarking data
- Open educational resources and experiences, with associated learning analytics

In our case studies, we have captured information on the current analytics activities of leading-edge institutions covering all these types of analytics and data sources. We have also addressed the institutional plans for the future.

Additional Definitional Work on Analytics

In recent months, some important definitional distinctions have been made by John Campbell,[3] George Siemens,[4] and Susan Grajek regarding elements of the analytics universe and the "Analytics Maturity Index" as described in Grajek's article in *EDUCAUSE Review*.[5] *Analytics in Higher Education: Benefits, Barriers, Progress, and Recommendations* is an excellent survey of IT and

[3] Van Barneveld, Arnold, and Campbell, "Analytics in Higher Education."
[4] Phil Long and George Siemens, "Penetrating the Fog: Analytics in Learning and Education," *EDUCAUSE Review* 46, no. 5 (September/October 2011), 34, http://www.educause.edu/ero/article/penetrating-fog-analytics-learning-and-education.
[5] Susan Grajek, "Research and Data Services for Higher Education Information Technology: Past, Present, and Future," *EDUCAUSE Review* 46, no. 6 (November/December 2011): 46–60, http://www.educause.edu/ero/article/research-and-data-services-higher-education-information-technology-past-present-and-future

institutional research (IR) professionals in several hundred institutions. A summary of these definitional materials by van Barneveld, Arnold, and Campbell is presented in Appendix A: More on Definitions for Analytics.

Context: The Era of "Big Data" and Analytics in Higher Education

Analytics in higher education is operating in a larger context: the emergence of so-called big data in virtually every industrial sector. While higher education lags other industries, we can learn much from the penetration and impact of big data in other sectors. Some of these insights can accelerate appropriate applications in colleges and universities.

The Era of Big Data Is Looming

Digital data is everywhere: in every sector, in every economy, in every organization using digital technology. The amount of data in the world is increasing rapidly, thus the capability to analyze large data sets—so-called big data—becomes a key basis of competition, underpinning new waves of productivity, growth, and innovation.[6]

New tools and practices. "Big data" refers to analysis of data sets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze. The ability to store, aggregate, and combine data and then use the results to perform deep analysis is becoming a reality. This capacity is further supported by digital storage and cloud computing, which are lowering costs and other technological barriers. The big data phenomenon is fueled by cheap sensors and high-throughput simulation models, the increasing volume and detail of information captured by enterprises, and the rise of multimedia, social media, and the Internet. It exists in many settings, ranging from social media to cell biology to market research, offering unparalleled opportunities to document the inner workings of many complex systems.[7]

McKinsey's team identified five ways to leverage big data that offer transformational potential to create value. These include: creating transparency; enabling experimentation to discover needs, expose variability, and improve performance; segmenting populations to customize actions; replacing/supporting human decision making with automated algorithms; and innovating new business models, products, and services. A critical factor, the McKinsey Report authors argued, is that there will be a shortage of talent necessary for organizations to take advantage of big data: "By 2018, the United States alone could face a shortage of 140,000 to 190,000 people with deep analytical skills as well as 1.5 million managers and analysts with the know-how to use the analysis of big data to make effective decisions."[8]

Building on interest in higher education. The interest among higher education institutions in analytics has grown since early projects impacting student success were highlighted by Campbell, DeBlois, and Oblinger. In their 2007 article "Academic Analytics," the authors cited that institutions' response to internal and external pressures for accountability in higher

[6] James Manyika et al., *Big Data: The Next Frontier for Innovation, Competition, and Productivity* (McKinsey Global Institute, 2012), http://www.mckinsey.com/Insights/MGI/Research/Technology_and_Innovation/Big_data_The_next_frontier_for_innovation.
[7] Ibid., 1.
[8] Ibid., 3.

education, especially in the areas of improved learning outcomes and student success, will require IT leaders to step up and become critical partners with academics and student affairs. They argued that IT can help answer this call for accountability through academic analytics, which was emerging as a critical component of the next-generation learning environment.[9]

In "Action Analytics: Measuring and Improving Performance that Matters," we, along with Leonard, Pugliese, and Lefrere, pointed out that "as the interest in academic analytics in higher education has grown, so have the escalating accountability demands that are driving performance measurement and improvement in interventions. Improving performance will require coordinated measurement, intervention, and action across the entire education/workforce spectrum—from 'cradle to career.'"[10]

Higher education is lagging. Big change is on the horizon across society.

> Research shows that we are on the cusp of a tremendous wave of innovation, productivity, and growth as well as new modes of competition and value capture—all driven by big data. While sectors will have to overcome barriers to capture value from the use of big data, barriers are structurally higher for some than for others. For example, the public sector, including education, faces higher hurdles because of a lack of a data-driven mind-set and available data.[11]

In analyzing sector involvement in big data, McKinsey determined a five-point assessment of the ease of capturing the value potential of data across sectors. These include:

- Overall ease of capture index
- Talent
- IT intensity
- Data-driven mind-set
- Data availability

These findings are captured in figure 3.

[9] John P. Campbell, Peter B. DeBlois, and Diana G. Oblinger, "Academic Analytics: A New Tool for a New Era," *EDUCAUSE Review* 42, no. 4 (July/August 2007): 40–57, http://www.educause.edu/ero/article/academic-analytics-new-tool-new-era.
[10] Donald M. Norris et al., "Action Analytics: Measuring and Improving Performance That Matters in Higher Education," *EDUCAUSE Review* 43, no. 1 (January/February 2008): 42–67, http://www.educause.edu/ero/article/action-analytics-measuring-and-improving-performance-matters-higher-education.
[11] Manyika et al., *Big Data*, 9.

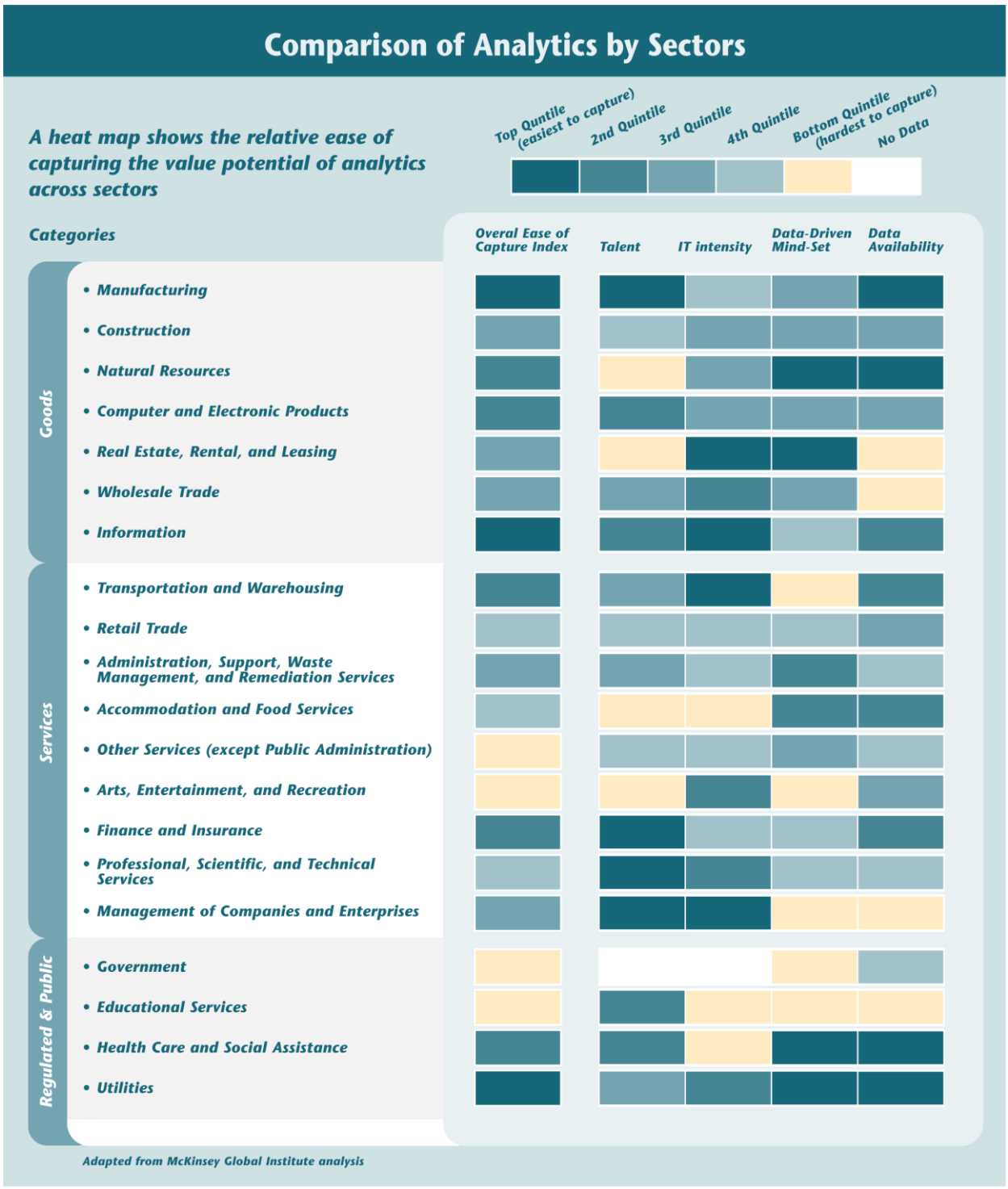

Figure 3. Comparison of analytics by sectors

In every category except talent, education is least prepared for ease of data capture, has the least capacity for IT intensity, least reflects the data-driven mind-set, and is the least likely to have overall data availability.

The McKinsey report reflects that some sectors with a relative lack of competitive intensity and performance transparency will likely be slow to fully leverage the benefits of big data. The public sector tends to lack the competitive pressure that limits efficiency and productivity—thus there are more barriers to capturing potential value from big data.[12]

In *Analytics: The New Path to Value*, Lavalle and others surveyed industry leadership in terms of barriers to improving the use of analytics. They concluded that the biggest obstacle is not the data but in two other factors: lack of understanding of how to use analytics to improve business and the lack of management bandwidth.[13] The emerging *Toolkit for Building Organizational Capacity for Analytics* will address these two important issues in terms of higher education.

Closing the analytics and big data gap. Analytics and big data offer the potential to identify promising practices, effective and efficient models, and powerful innovations, sustaining higher education for the future. They promise to pose and answer questions we could not even frame without big data.

In *Game Changers*, Diana Oblinger pointed out that there are many ways that information technology can serve as a major game changer in developing and supporting the organizational capacity in analytics in higher education. She referenced using IT as a delivery channel for information and IT-based services and engagement, creating unique experiences in learning or student support. Perhaps most important for the future are the examples of IT enabling alternative models that improve choice, decision making, and student success.[14]

Yet, as Grajek pointed out, the higher education sector has not kept pace with the demand for more actionable and truly comparable information; research is still essentially opportunistic and descriptive in nature. However, data expands the capacity and ability of organizations to make sense of complex environments. Implementing analytics and applying it to make data-driven decisions is a major differentiator between high-performing and low-performing organizations.[15]

In *Analytics in Higher Education: Benefits, Barriers, Progress and Recommendations*, Bichsel described the ECAR survey of IT and IR professionals at several hundred institutions regarding the use of analytics in all applications. The study assessed the current state of analytics in higher education, outlined the challenges and barriers to analytics, and provided a basis for benchmarking progress in analytics. The survey found the following to be campus targets for the use of analytics:

- Enrollment management
- Finance and budgeting
- Student progress

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[12] Ibid.

[13] Steve Lavalle et al., *Analytics: The New Path to Value*, MIT Sloan Management Review Research Report, Fall 2010 http://cci.uncc.edu/sites/cci.uncc.edu/files/media/pdf_files/MIT-SMR-IBM-Analytics-The-New-Path-to-Value-Fall-2010.pdf.

[14] Diana Oblinger, ed., *Game Changers: Education and Information Technologies* (Louisville, CO: EDUCAUSE, 2012), http://www.educause.edu/books.

[15] Grajek, "Research and Data Services," 49; Lavalle et al., *Analytics*.

- Instructional management
- Central IT
- Student learning
- Progress of strategic plan
- Alumni advancement
- Research administration[16]

The report goes on to describe a set of components that relate to a maturity index in analytics development. They include culture/process, investment, data/reporting/tools, expertise, and governance/infrastructure.[17]

Authors on the topic have begun to address the value added by developing analytical capacity. Long and Siemens described the following components that increase the efficiency and effectiveness of higher education when analytics is employed:

- Improve administrative decision making and organizational resource allocation.
- Identify at-risk learners and provide intervention to assist learners in achieving success.
- Create, through transparent data and analysis, a shared understanding of the institution's successes and challenges.
- Innovate and transform the college/university system, as well as academic models and pedagogical approaches.
- Assist in making sense of complex topics through the combination of social networks and technical and information networks; that is, algorithms can recognize and provide insight into data and at-risk challenges.
- Help leaders transition to holistic decision making through analyses of what-if scenarios and experimentation to explore how various elements within a complex discipline (e.g., retaining students, reducing costs) connect and the impact of changing core elements.
- Increase organizational productivity and effectiveness by providing up-to-date information and allowing rapid response to challenges.
- Help institutional leaders determine the hard (e.g., patents, research) and soft (e.g., reputation, profile, quality of teaching) value generated by faculty activity.
- Provide learners with insight into their own learning habits and give recommendations for improvement. A learning-facing analytics tool, such as the University of Maryland, Baltimore County's Check My Activity, allows learners to "compare their own activity…against an anonymous summary of their course peers."[18]

[16] Jacqueline Bichsel, *Analytics in Higher Education: Benefits, Barriers, Progress, and Recommendations*, research report (Louisville, CO: EDUCAUSE Center for Applied Research, 2012), 10, http://net.educause.edu/ir/library/pdf/ERS1207/ers1207.pdf.
[17] Ibid., 22–23.
[18] Long and Siemens, *Penetrating the Fog*, 36.

Our survey and analysis confirmed that analytics is poised to play a major role in accelerating the improvement of student and institutional performance in the coming years.

Selecting Institutions for the Analytics Survey

In selecting institutions for the survey, we decided to find and showcase exemplary practices, not the average state of the industry. We sought institutions with demonstrable success in using analytics to improve student success. So we identified a pool of institutions with the following characteristics:

- Institutions that had been showcased as part of the First and Second National Symposia on Action Analytics
- Institutions that had been profiled in the white paper "What's New in Analytics in Higher Education?," which was published after EDUCAUSE 2010
- Institutions that had been awarded Next Generation Learning Challenges (NGLC) grants by the Bill & Melinda Gates Foundation
- Institutions recommended for inclusion during the course of the interview process
- Institutions included in Achieving the Dream, Completion by Design, and comparable programs

The sample represents a range of institutional types, sizes, and geographical locations, as portrayed in figure 4. Summary characteristics for each category are portrayed in figure 5. The following description is organized by institutional type.

For-profit universities and not-for-profit, primarily online universities are among the most advanced in their embedding of predictive analytics into academic and administrative processes. As a group, we found the for-profit universities the most advanced in having developed

- a strong, top leadership commitment to performance analytics,
- pervasive cultures and behaviors of performance measurement and improvement, and
- predictive analytics embedded in academic and academic support/administrative processes.

These institutions rely on analytics-supported service as a source of competitive advantage. While the for-profits were first to market with advanced analytics, not-for-profit, primarily online institutions, such as the University of Maryland University College, have also deployed such tools and the culture to support their pervasive use.

Our group of for-profit and not-for-profit, primarily online institutions includes the American Public University, Capella University, University of Phoenix–Online Campus, Kaplan University, University of Maryland University College, and Southeastern Iowa Online Consortium.

Research universities are perhaps the most sophisticated ICT enterprises in higher education. They provide world-class ICT capabilities/services (including analytics) to highly diverse,

complex, and sophisticated communities of users. They are complex and decentralized and have a prevailing culture of faculty autonomy.

These characteristics complicate changing organizational culture and achieving consistent, pervasive behaviors relating to performance measurement and improvement. Some of these universities use highly sophisticated student success analytics at the department/school level. Others, like Purdue, UMBC, and Arizona State, have made significant investments in student success analytics for some time, realizing significant results, and are recognized as exemplary practice leaders.

Our research universities include Purdue University, Arizona State University, University of Central Florida, UMBC, Colorado State University, University of Delaware, and University of Michigan.

Leading Universities in Survey

Category	Institutions	
Primarily Online Universities	*For-Profit Online Universities:* • The American Public University System • Capella University • University of Phoenix – Online Campus • Kaplan University	*Not-for-Profit Online Universities:* • University of Maryland University College • Southeastern Iowa Online Consortium
Research Universities	• Purdue University • Arizona State University • University of Central Florida • University of Maryland Baltimore County	• Colorado State University • University of Delaware • University of Michigan
Comprehensive Universities	• Ball State University • Northern Arizona University • Saint Cloud State University • Northern Kentucky University	• University of Baltimore • Harris-Stowe State University • Coppin State University
Private Colleges and Universities	• Colorado College • Northeastern University • Wake Forest University	• Southeastern New Hampshire University • Paul Smith's College • University of Richmond
Community and Technical Colleges	• Cuyahoga Community College • Northern Virginia Community College • Rochester Community and Technical College	• Rio Salado College • Sinclair Community College • Valencia Community College
Systems of Institutions	• South Orange County Community College System • State Universities of New York • Iowa Community College System/ Southeastern Community College • University of Hawaii System	• Minnesota State Colleges and Universities • Virginia Community College System • Florida Community Colleges • Colorado Community College System

Figure 4. Leading universities in the analytics survey

Comprehensive universities are among the strongest candidates for high ROI from student success analytics and interventions. Many of these institutions in the case studies are achieving impressive, demonstrable improvements in student success. The American Association of State Colleges and Universities (AASCU), which represents many of these institutions as a professional association, has been a major supporter of analytics in higher education.

Our comprehensive universities include Ball State University, Northern Arizona University, St. Cloud State University, Northern Kentucky University, University of Baltimore, Harris-Stowe State University, and Coppin State University.

Private colleges and universities were among the early adopters of strategic enrollment management as applied to the student pipeline and freshmen experience/gateway courses. While our selection of private institutions varies dramatically in size and mission, they provide some interesting strategies and approaches to analytics. Some can point to demonstrable improvements in student success from their analytics applications.

Our private colleges and universities include Colorado College, Northeastern University, Wake Forest University, Southeastern New Hampshire University, Paul Smith's College, and University of Richmond.

Community colleges are using analytics for multiple purposes: K–12 to postsecondary bridging and pathways programs, remediation reductions, student success improvements, and workforce planning. Community colleges like Rio Salado, Cuyahoga Community College, and Sinclair Community College are highly sophisticated, with demonstrable results from their analytics-supported interventions. Given the growing importance of community colleges in the American higher education landscape (increasing enrollments, tight linkage with job placement and employment), analytics holds great promise in this sector. The American Association of Community Colleges (AACC), which represents community, junior, and technical colleges, is very active in promoting student success analytics.

Our community college interviews included Cuyahoga Community College, Northern Virginia Community College, Rochester Community and Technical College, Rio Salado College, Sinclair Community College, and Valencia Community College.

Systems of institutions present opportunities for analytics that can manage and improve student success across the different campuses in the system and down into individual institutions. These institutions also illustrate the technical, organization, and political challenges of attempting to enhance analytics capabilities in multi-institution settings.

We interviewed South Orange County Community College System, State Universities of New York, Iowa Community College System/Southeastern Community College, University of Hawaii System, Minnesota State Colleges and Universities, Virginia Community College System, Florida Community Colleges, and Colorado Community College System. Some of the individual institutions we interviewed also belong to systems of institutions.

As we proceed with the analysis and meta-analysis of these results, they will be posted and made available to the higher education community. Through our interviews, we have identified at least another 20 institutions worthy to be included as exemplars.

Summary of Findings, Institutional Type

Category	Summary Description
Primarily Online Universities	***For-profit universities*** *have been the earliest and most advanced in having developed:* *1) a strong, top leadership commitment to performance analytics,* *2) pervasive cultures and behaviors of performance measurement and improvement, and* *3) embedding predictive analytics in academic and academic support/administrative processes. They rely on analytics-supported service as a source of competitive advantage. While the for-profits were first to market with advanced analytics, not-for-profit, primarily online institutions such as the UMUC have also deployed such tools.*
Research Universities	***Research Universities*** *are perhaps the most sophisticated ICT enterprises in higher education. They provide world-class ICT capabilities/services (including analytics) to highly diverse, complex and sophisticated communities of users. They are complex, decentralized, and have a prevailing culture of faculty autonomy. This complicates changing organizational culture and achieving consistent, pervasive behaviors relating to performance measurement and improvement.* *Some of these universities use highly sophisticated student success analytics at the department/school level. Others like Purdue, UMBC, and Arizona State have made significant investments in student success analytics for some time, realized significant results, and are recognized as exemplary practice leaders.*
Comprehensive Universities	***Comprehensive Universities*** *are among the strongest candidates for high return on investment from student success analytics and interventions. Among our case studies, many of these institutions are achieving impressive, demonstrable improvements in student success.* *The American Association of State Colleges and Universities (AASCU), which represents many of these institutions as a professional association, has been a major supporter of analytics in higher education.*
Private Colleges and Universities	***Private Colleges and Universities*** *were among the early adopters of strategic enrollment management as applied to the student pipeline and freshmen experience/gateway courses.* *While our selection of private institutions varies dramatically in size and mission, they provide some interesting strategies and approaches to analytics. Some can point to demonstrable improvements in student success from their analytics applications.*
Community and Technical Colleges	***Community Colleges*** *are a rapidly growing sector. They are actively engaged in analytics focused on student success. Community colleges like Rio Salado, Cuyahoga Community College, and Sinclair Community College are highly sophisticated, with demonstrable results from their analytics-supported interventions.* *The American Association of Community Colleges (AACC), which represents community, junior, and technical colleges, is very active in promoting student success analytics.*
Systems of Institutions	***Systems of Institutions*** *present opportunities for analytics that can manage and improve student success across the different campuses in the system and down to individual institutions. These institutions also illustrate the technical, organization, and political challenges of attempting to enhance analytics capabilities in multi-institution settings.*

Figure 5. Summary of findings by institutional types

Selecting Solution Providers for the Survey

We selected a set of 20 solution providers that are the leaders in the industry, based on recommendations from leading institutions and vendor participation in trade shows such as EDUCAUSE. These solution providers are portrayed in figure 6, as are a group of potential vendors for future inclusion in our ongoing survey.

Leading Solution Providers in Survey

Categories	First Round – Solution Providers (Initial 20 grew to 22)		Second Round – Additional Solution Providers (20 to 30 Candidates)	
ERP/BI	• Oracle/PeopleSoft/ Hyperion • Ellucian (Datatel/SunGard) • Campus Management	• Jenzabar • SAP/Business Objects • Workday (Big Data offering)	• Top School • Destiny Solutions • Adobe	
LMS	• Blackboard/ iStrategy • Moodlerooms • Desire2Learn	• Pearson/eCollege • LoudCloud • Sakai	• Instructure/Canvas • Campus Cruiser • Appendra	
Visualization/CRM Dashboard/Analytics Consulting/Generalized Advising	• IBM (SPSS/Cognos) • Microsoft • eThority	• Nuventive • eVisions • Pentaho	• iDashboard • Tableau	• QlikTech
Advising/CRM → Learning Relationship Management	• Starfish Retention Solutions • Civitas	• EBI/MAPWorks • RapidInsight	• Hobsons • Respondus • Salesforce.com	• Talisma • ConnectEDU • Campus Lab
Personalized Learning Environments			• WebStudy • Knewton • Cengage • Turning Technologies • Epsilen • SoftChalk	• Ucompass • eXact Learning Solutions • GoingOn • SMART Technologies

Figure 6. Leading solutions providers

Interest in analytics in higher education began with the efforts of a group of business intelligence tool and solution providers (Cognos, Hyperion, Business Objects, SPSS). These were subsequently acquired by ERP and analytics companies (IBM, Oracle/PeopleSoft, SAP, SunGard) and embedded in their offerings.

This corporate consolidation continued as Ellucian was formed by the combination of Datatel and SunGard. Over time, analytics applications and supporting consulting services were added by the LMS providers. Moreover, a new cadre of analytics and consulting providers entered the marketplace. They were joined by firms specializing in advising and retention solutions and

adapting customer relationship management (CRM) to retention and student success applications.

In response to these developments our initial sample of solution providers included:

- **BI/ERP companies**—Oracle/PeopleSoft/Hyperion, SunGard, Datatel (SunGard and Datatel have since merged and been rebranded as Ellucian), Campus Management, Jenzabar, and SAP/Business Objects, Top School, and Workday (an HR/financial provider that has also announced a big data offering)
- **LMS companies**—Blackboard/iStrategy, Desire2Learn, Moodlerooms (Moodlerooms has since been acquired by Blackboard), Sakai, Pearson/eCollege, and LoudCloud
- **Analytics, consulting, visualization, dashboard**—IBM (SPSS/Cognos), Microsoft, eThority, Nuventive, eVisions, and Pentaho
- **Advising/retention companies**—Starfish Retention Solutions, EBI/MAP-Works, RapidInsight, and Civitas, which are evolving toward becoming LRM solutions

Over time, we expect to invite new solution providers progressively to participate in our survey. An initial cut at potential candidates includes the following:

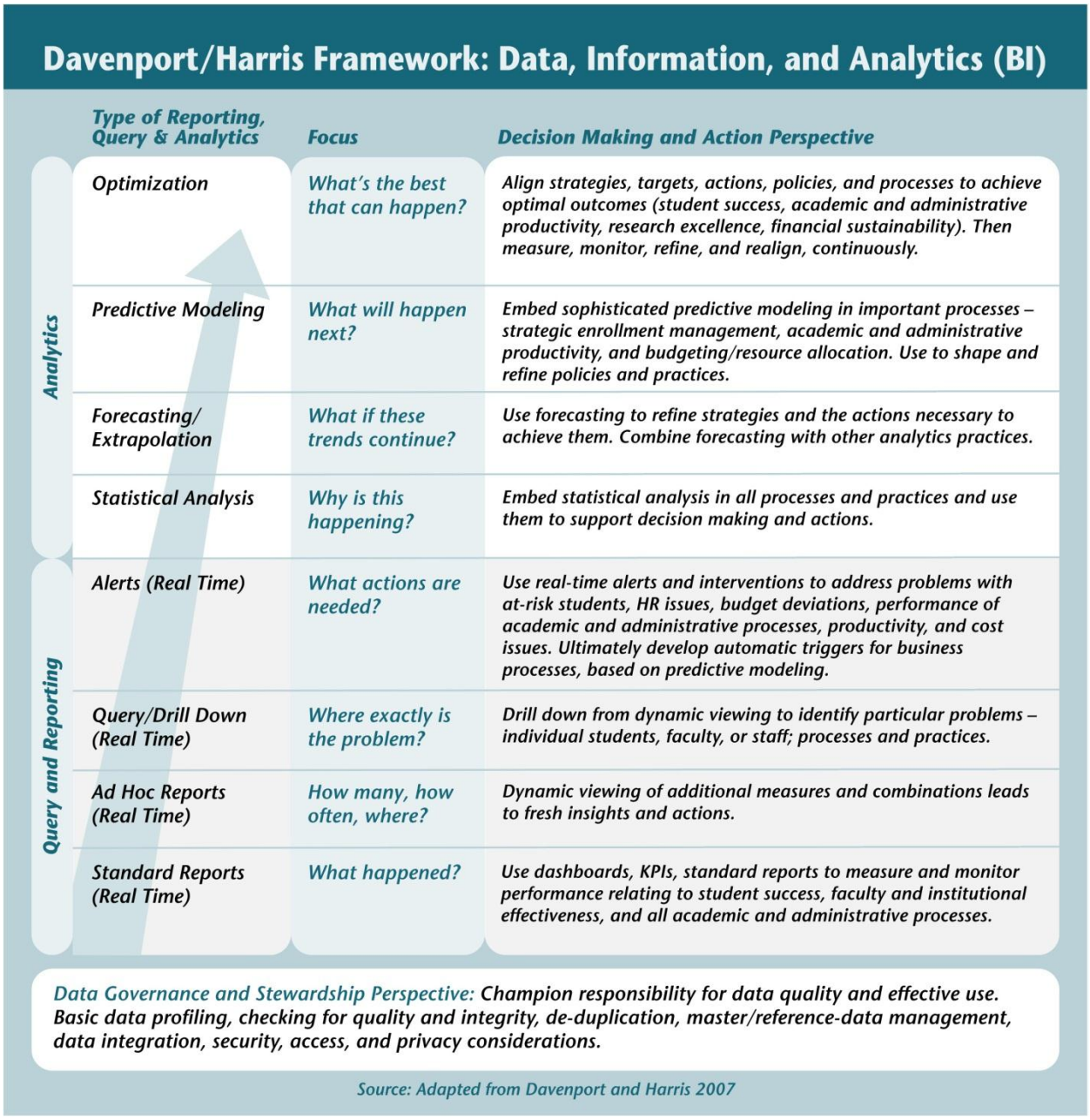
- Other ERP, LMS, student response systems, and analytics tools providers (Instructure/Canvas, Campus Cruiser, Destiny Solutions, Adobe, Hobsons, Respondus, ConnectEDU, and Campus Labs), plus dashboard and visualization providers (iDashboard, Tableau, QlikTech); perhaps customer/constituent relationship management (CRM) providers like Salesforce.com, Talisma LMS, and analytics firms from K–12 and workforce marketplaces that are expanding to include higher education (Appendra)
- Personalized learning environment providers that will figure prominently in the expansion of personalized learning and learning analytics (WebStudy, Knewton, Cengage, Turning Technologies, Epsilen, SoftChalk, Ucompass, eXact Learning Solutions, GoingOn, SMART Technologies, and others)
- Open resource providers that may be part of the learning analytics movement (to be determined)

Over time, solution providers will be interviewed and their surveys added to our database. In addition we will consider including "productized" offerings like Purdue Signals as solution providers' offerings. We have noted over time that many of the ERP and LMS solution providers have begun to describe their capabilities in terms of the learner relationship management concept. The level of sophistication of this message is growing rapidly.

Actions for Optimizing Student Success Using Analytics

Optimizing student success encompasses all the actions, activities, policies, and practices that actively support student success at all stages of the student experience. In collecting information from our selection of leading practitioner universities, we used the Davenport/Harris framework as one point of reference. We embedded the elements of this framework in the

interview questions about their institutional organizational capacity to deal with data, information, reporting, query, and analytics.



Davenport/Harris Framework: Data, Information, and Analytics (BI)

	Type of Reporting, Query & Analytics	Focus	Decision Making and Action Perspective
Analytics	Optimization	What's the best that can happen?	Align strategies, targets, actions, policies, and processes to achieve optimal outcomes (student success, academic and administrative productivity, research excellence, financial sustainability). Then measure, monitor, refine, and realign, continuously.
Analytics	Predictive Modeling	What will happen next?	Embed sophisticated predictive modeling in important processes – strategic enrollment management, academic and administrative productivity, and budgeting/resource allocation. Use to shape and refine policies and practices.
Analytics	Forecasting/ Extrapolation	What if these trends continue?	Use forecasting to refine strategies and the actions necessary to achieve them. Combine forecasting with other analytics practices.
Analytics	Statistical Analysis	Why is this happening?	Embed statistical analysis in all processes and practices and use them to support decision making and actions.
Query and Reporting	Alerts (Real Time)	What actions are needed?	Use real-time alerts and interventions to address problems with at-risk students, HR issues, budget deviations, performance of academic and administrative processes, productivity, and cost issues. Ultimately develop automatic triggers for business processes, based on predictive modeling.
Query and Reporting	Query/Drill Down (Real Time)	Where exactly is the problem?	Drill down from dynamic viewing to identify particular problems – individual students, faculty, or staff; processes and practices.
Query and Reporting	Ad Hoc Reports (Real Time)	How many, how often, where?	Dynamic viewing of additional measures and combinations leads to fresh insights and actions.
Query and Reporting	Standard Reports (Real Time)	What happened?	Use dashboards, KPIs, standard reports to measure and monitor performance relating to student success, faculty and institutional effectiveness, and all academic and administrative processes.

Data Governance and Stewardship Perspective: **Champion responsibility for data quality and effective use. Basic data profiling, checking for quality and integrity, de-duplication, master/reference-data management, data integration, security, access, and privacy considerations.**

Source: Adapted from Davenport and Harris 2007

Figure 7. The Davenport/Harris framework

The Davenport/Harris framework cites "Optimization—achieving the best that can happen" as the highest pinnacle of achievement of data/information/analytics use. Davenport/Harris focused on how businesses and industries used analytics to optimize competitiveness.[19] In

[19] Thomas H. Davenport and Jeanne G. Harris, *Competing on Analytics* (Cambridge, MA: Harvard Business School Press, 2007).

higher education, analytics optimizing student success consists of an array of actions that institutions pilot test, then embed in their academic and administrative support processes.

We found that the success of learners in achieving their objectives was enhanced by a wide range of complementary initiatives and actions. These include both established practices and many emerging developments with comparable promise. Institutions today are discovering ways to proactively optimize student success by deploying combinations of actions and interventions to achieve the best outcomes possible.

Norris/Baer Framework: Optimizing Student Success through Analytics

These initiatives and actions are supported by increasingly sophisticated combinations of the reporting, query, and analytics included in the Davenport/Harris framework, and more. To describe the analytics activities of our leading institutions, we use the following array of analytics-enabled student success activities. This array emerged from analysis of the actual practices of leading institutions.

Figure 8 describes the seven elements of the framework and provides examples. This framework maps the actual initiatives institutions are undertaking today. It also suggests migration paths to future practice. In theory, adding improved versions of these seven categories of actions can continue to improve retention and the rates of achieving academic goals (competencies, certificates, degrees, employment). The categories are important as a suite of activities, and institutions gain more improvements over time when integrating support in each of these areas.

Manage the student pipeline. As part of their strategic enrollment management (SEM) initiatives, institutions have been using longitudinal analytics and predictive modeling to attract and select students likely to achieve success. They have also shaped policies, practices, and processes to identify and provide a variety of support services to at-risk students, enhancing their chances of educational success once enrolled. These practices have been extended into institutional programs for the first-year experience, gateway courses, and retention improvement.

Among our 40 institutions, virtually all are using analytics to manage and improve the pipeline of incoming students. Prospective additions to their SEM practices could include attracting and selecting high-performing students who motivate and support other students, helping to enhance their peers' success and the institution's reputation.

Examples of managing the student pipeline include:

- Virginia Community Colleges is actively engaged on high school campuses to advise, recruit, and prepare students for successful college entrance.
- University of Michigan utilizes SEM to identify at-risk students and provide mentoring and support services that have dramatically improved the success of these students.

Eliminate impediments to retention and student success. Many institutions have unwittingly erected structural, policy, and programmatic impediments to student progress, retention, and success. Many institutions and groups, like the Education Trust, have demonstrated the

effectiveness of assessing and eliminating academic bottlenecks, enhancing gateway courses, focusing on the first-year experience, and undertaking other measures shown to improve student success for all students, but especially at-risk students.

Norris/Baer Framework: Optimizing Student Success through Analytics

Elements	Description	Examples
1. Manage the student pipeline	Scientifically refine strategic enrolment management of the student pipeline.	• Use data mining and predictive analytics to improve the recruitment, admission, and enrolment of entering students (raise numbers and improve chances of student success; and • Use longitudinal and predictive analytics to craft policies for improving success of **at-risk students**.
2. Eliminate impediments to retention and student success	Eliminate structural, policy, and programmatic impediments to retention and success.	• Use analytics to support **comprehensive** first-year programs; • Eliminate bottlenecks in courses and program progressions; unreasonable pre-requisites and other requirements; and • Use predictive analytics to shape policies and practices to enhance retention in sophomore-senior years.
3. Utilize dynamic, predictive analytics to respond to at-risk behavior	Embed analytics in academic and administrative support processes to enable real-time interventions dealing with at-risk behaviors, both academic and co-curricular.	• Use dynamic, predictive analytics to determine at-risk behavior in courses early in the semester; Embed predictive analytics in processes; and • Monitor levels of student engagement in academic and co-curricular activies and intervene with students who can be saved.
4. Evolve learner relationship management systems	Build tracking systems that can track and manage the many facets of learner progress and identify and respond to at-risk behavior.	• Create the learner equivalents of customer relationship management functionality, supported by predictive analytics; and • Extend dynamic, predictive analytics to learner relationship management.
5. Create personalized learning environments/ learning analytics	Embed personalized learning analytics into learning management systems and learner relationship management systems	• Create personalized learning modes with embedded predictive performance analytics; • Use these analytics-rich systems to personalize learning outcomes; and • Create learning experiences reaching beyond formal curricula.
6. Engage in large-scale data mining	Use data mining to illuminate pathways to student success and discover unforeseen insights.	• Leverage data mining to drive predictive modelling in processes; • Use forensic data mining to explore unthought-of correlates of success; and • Engage in cross-institutional comparisons and cross-sectoral comparisons.
7. Extend student success to include learning, workforce, and life success	Expand the definition of student success to include the entire student lifecycle – cradle to career, including learning, work, learning-to-work transitions, and workforce success.	• Extend into Alumni analytics; • Undertake data mining spanning institutions, industries, and sectors; and • Pioneer pathway-to-success analysis.

Figure 8. Norris/Baer framework

These approaches are widely practiced and have produced measureable success. The most effective of these programs use predictive analytics to identify and support at-risk students.

Examples of such actions include:

- Offering comprehensive "first-year experience" programs that focus on the first year, when attrition is more pernicious.
- Undertaking structural realignment to eliminate bottlenecks in course and program progressions, unreasonable prerequisites, and other requirements having unintended, detrimental consequences. The report *Winning by Degrees* relates that in order to improve productivity, campuses must focus on reducing nonproductive credits; that is, reducing failed credits and withdrawals, focusing on reducing credits, and honing in on more core instructional offerings.[20] Designing curriculum around a full summer semester increased the timely completion for students at BYU–Idaho and University of Northern Texas.
- Using predictive analytics to shape policies and practices to enhance retention in sophomore through senior years. These practices include limiting the number of credits lost during transfer and strict policies on withdrawal and academic progress. Strengthening and enforcing transfer policies is especially important in guarding against redundant credits.

All of the 40 institutional leaders are using analytics to remove barriers to success. Prospective enhancements include cross-institution analytics, to identify transferrable ways to spot and remove impediments to success.

Use dynamic predictive analytics to respond to at-risk behaviors. The first two categories deal with mitigating the risks for at-risk students and eliminating risk-enhancing aspects of policies, processes, and structures. This third category involves using analytics to dynamically identify and deal with *at-risk behavior* for all students, preferably in real time or as close to real time as possible. It features embedding analytics in academic and administrative support processes to enable real-time interventions, in some cases automatically.

A cluster of leading-edge institutions are using the new generation of analytic applications to enable dynamic analysis of student performance, inform students, and provoke interventions immediately when students display at-risk behaviors. Dynamic viewing means that the end user can literally "push a button" or view an institutional dashboard or Bloomberg-type displays to see updated versions of standard reports on student progress and status. Or users can access a user-friendly data utility to easily select different combinations of variables, and then easily request new reports and queries that can lead to dynamic drilldowns that identify individuals among groups of students displaying risky behavior. Alerts and tailored interventions follow.

Many of these practices can scan course, student, and financial information. They can even scan not just academic behaviors but also the intensity of the student's engagement in co-curricular

[20] Byron G. Auguste et al., *Winning by Degrees: The Strategies of Highly Productive Higher-Education Institutions*, McKinsey & Company, November 2010, http://mckinseyonsociety.com/downloads/reports/Education/Winning%20by%20degrees%20execsum%20v5.pdf.

activities and administrative systems. Many use predictive analytics so that at-risk behavior thresholds can be established as tripwires that provoke automatic, yet tailored, interventions, depending on the students' characteristics.

The best of the leading institutions are progressively embedding predictive analytics into both academic and administrative processes. In this way, they can automatically provoke responses to at-risk behavior and track/manage learner outcomes. Among the for-profit institutions and online institutions in our group, embedded predictive analytics are standard operating procedure.

- Purdue's Signals program, which has been productized by SunGard, is the best-known example of embedded, predictive course analytics. It produces red, yellow, and green evaluations of student behaviors in comparison with past behavior of successful students.
- Rio Salado College has developed an eighth day "at risk" model that assesses the likelihood of a student's successful completion using past enrollment, LMS activity data, and current enrollment status as indicators. They also have developed the SOS—Status of Student—model, which implements warning levels on a weekly basis using frequency of student log-in, site engagement, and pace in completing a course as indicators.
- The University of Phoenix has studied which factors are "good" predictors and "low" predictors for course completion. They have found that good predictors include scores earned in current course, credits earned, credits attempted, difference between past and current scores, prior course points, GPA, and financial status.
- Arizona State University has improved its retention rates by 4–5% through leveraging Sun Devil Tracking and eAdvisor.
- American Public University System (APUS) has created a predictive model that is 91% accurate in predicting student disenrollment for the coming five semesters. They take a comprehensive look every week at all enrolled students, ranked in order based on their likelihood of not being retained.
- Other variations on embedded, dynamic, and predictive analytics are on display at many of the other institutions: UMBC and Coppin State University, to name a few. More details will be provided in subsequent versions of this report.

Evolve and leverage learner relationship management systems. Student information systems are transaction-based systems that are a module in institutional ERP systems. Learning management systems are organized around courses. Advising and customer relationship management systems are organized around individuals. One of the key developments in analytics systems is the evolution of a variety of analytics-infused systems that are essentially "learner relationship management" approaches. Most combine embedded analytics to flag at-risk behavior.

Customer relationship management builds on what experts in service science and service systems are applying to higher education.

> Service science asserts that the customer and the service provider co-create value. Value is not in the product (e.g., a course or a degree) but in the experience created by interaction, such as that between faculty and students. For example, the real value of a course may lie in the critical thinking a faculty member encourages in a student, the integration of content with real-world experience, and the motivation to continue learning and solve important problems.[21]

Leading institutions and vendors are developing the first generation of LRM tools/applications that embed CRM capabilities. For example:

- Northeastern University has adapted Salesforce.com to create a sort of LRM system for advancing student success.
- Sinclair Community College has developed the Student Success Plan (SSP), a case management and intervention software system it is turning into an open-source product with a community of practice of users at institutions deploying this holistic advising utility.
- South Orange County Community College System has developed SHERPA, a system for following student progress and providing "nudges" toward success.
- Arizona State University's eAdvisor System enables predictive analytics-enabled evaluation of student behavior and learner tracking against norms.
- Capella University's learning-objective mapping system provides guidance for each student and is at the heart of their competence-based approach to learning and student success.
- Rio Salado's Student Success Model monitors each student's progress/success/at-risk indicators.
- Retention systems and services such as those offered by Starfish and EBI/MAP-Works use many LRM-like features.
- ERP-for-online-learning systems like TopSchool can provide an LRM look for dealing with students.
- New systems under development by vendors enable the dynamic evaluation of learner success relative to predictive analytics-based norms in all courses, providing a more holistic view than course-by-course assessments.

These early-stage systems can be positioned to evolve and accommodate personalized learning practices and learner analytics at the course/learning experience level. Future versions of this report will describe in greater detail the development of LRM capabilities.

Create personalized learning environments/learning analytics. Personalized learning practices and learning analytics are being actively embedded into academic courses and programs so that learning experiences can be fashioned to optimize learning outcomes for each individual. Over the next few years, learning analytics practices are positioned to grow considerably in sophistication, with widespread application and deployment. An area where personalized learning environments are being explored is through the Bill & Melinda Gates Foundation

[21] Oblinger, "IT as a Game Changer," *Game Changers*, 38–39.

project in the Next Generation Learning Challenges initiative. This initiative actively supports prototype projects that are piloting personalized learning, open educational resources, and learning analytics concepts.

Over time, personalized learning and learning analytics will add another dimension to the improvement of learner success and completion of degree goals. These innovations will require both existing enterprise systems and next-generation learning management systems to accommodate new course structures, fresh approaches to evaluation and grading, and other innovative practices. They likely will hasten and shape the next generation of core systems in the cloud. They will also foster the development of open, free-range learning alternatives that will operate parallel to and outside existing institutional learning and enterprise systems.

The dual potentials of personalized learning and learning analytics are nicely portrayed by George Siemens and Phil Long in a recent *EDUCAUSE Review* article.[22] At the same time, personalized learning environments and enhanced learning analytics will stimulate the emergence of immersive learning experiences that occur outside of institutional learning environments and the enterprise systems that support them. One of the important challenges that will confront enterprise systems for student success is how they will accommodate, incorporate, emulate, and certify aspects of free-range, do-it-yourself personal learning more attuned to real-world experiences, employers, and emerging challenges. These learning and competence-building opportunities will operate beyond the restrictions of the academic curriculum.

Engage in large-scale data mining. As Vernon Smith noted in *Game Changers*,

> Colleges and universities collect mountains of data in their student information, learning management, and other systems. At the same time, students come and go—often at predictable "loss points" such as the transition from high school to college, during remedial education, and so on.
>
> In one scenario, higher education would use the power of information technology to mine student information and data on a massive scale across multiple institutions. This would involve aggregating, mining, and identifying the key momentum and loss variables, and then scaling up solutions that effectively address those factors. The idea would be to then create predictive models through the use of advanced statistical modeling that would identify possible stumbling blocks and help drive early interventions for students, especially low-income young adults and minorities. A growing body of best practices and interventions that remove barriers to student progress and success exists, but those interventions would be better informed if they were based on what the research and actual behaviors indicate, rather than on anecdotal notions or experience alone.[23]

Data mining is the process of discovering new patterns from large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. Most of our 40 institutions are engaged in some form of large-scale, longitudinal data analysis and comparative research to discover insights into "what works" in making students successful.

[22] Long and Siemens, *Penetrating the Fog*.
[23] Vernon C. Smith, "Scaling Up: Four Ideas to Increase College Completion," *Game Changers,* 109.

The best of such efforts don't just answer preset research questions; they mine the data to identify unexpected patterns and relations and thereby frame and answer fresh questions.

Most of the institutions interviewed expect to engage in larger-scale data-mining projects in the future. These will be used forensically to explore unthought-of correlates of student success and linked to reinventions and retuning of policies, process, and practices.

In addition, cross-institutional data mining for insights is growing. For example the Predictive Analytics Reporting (PAR) Project being undertaken by the Western Interstate Commission for Higher Education (WICHE) is creating a federated data set for six institutions and almost 800,000 student records; this will enable data mining across the data set. The project is deconstructing the problems of retention, progress, and completion to find solutions to decrease loss and increase momentum and success. The PAR partner institutions (American Public University System, Colorado Community College System, Rio Salado College, University of Hawaii System, University of Illinois–Springfield, and the University of Phoenix) are federating and aggregating more than 600,000 de-identified online student records and will apply descriptive, inferential, and predictive analytical tests to the single pool of records to look for variables that seem to affect student achievement.[24]

Pearson/eCollege is using its cloud-based operations to enable data mining to identify student success factors and patterns across its institutional clients. Moreover, consortia of institutions are pursuing cross-institution comparisons of "what works" and analyzing the complexity of student transitions among different institutions. Many states have K–16 initiatives that are using large data sets to explore issues relating to high school-to-college transitions.

The University of Central Florida leverages its PhD-level data-mining program, which harnesses faculty and students to engage and solve institution-wide grand-challenge problems such as fundraising and retention. They have successfully used advanced data mining to successfully identify through predictive analytics 80–85% of at-risk students.

In the future, big data approaches will become increasingly common in higher education, as they already are growing in other industries. These approaches will cross institutional boundaries, span K–20, and even link learning and workforce data sets. Our definitions will need to expand to encompass these emerging best practices.

Extend student success to include learning, workforce, and life success. A number of the institutions in our group of leading practitioners include employability and workforce issues in their institution-focused analytics efforts. Federal requirements for gainful employment reporting encourage such developments, which are expected to grow in the future.

Cloud-based analytics holds great promise for cross-institution and cross-sector analysis that will enable the extension of student success to include achievement of learning outcomes, preparation for employability, transitions between learning and work and back again, and workforce development.

[24] Ibid., 110.

Today, some practitioners are extending the definition of learner success beyond certificate or degree completion to include data on competences, employability, learning-to-work transitions, and even employment success. Future comparative studies and data mining are likely to combine learning and workforce elements and identify success-building behaviors and experiences. Today's exemplary practices are the leading edge of these evolutionary developments. These practices include early life and career mapping tools as well as strong integration with national skills and competencies.

Examples of workforce applications include the following:

- LifeMap is Valencia College's developmental advising system, promoting student social and academic integration and education and career planning, as well as acquisition of study and life skills. It creates a normative expectation for students that they have a career and educational plan early in their enrollment at Valencia and integrates a system of tools, services, programs, and people (faculty and staff) to engage with students to document, revise, and develop those plans.[25]
- Northeastern University is very successful in student outcomes with their cooperative education ("co-op") model. Approximately 92% of their student graduates are either immediately employed or attend graduate school. They are striving to understand just why the model is so successful.
- The Minnesota State Colleges and Universities System uses analytics to understand workforce issues; it uses national skill sets data to develop course and degree pathways and to fit them together.

Many of the responding institutions suggested that workforce analytics was one of their next targets.

From foundation to advanced practice. Today's pioneering efforts in using analytics to advance student success are setting the stage for even greater strides in the near future.

> Analytics will be an essential future part of higher education. Institutions' previous efforts of capturing data, providing availability in data warehouses, and initial data mining efforts are foundational to the next generation of activities. Higher education is benefiting from the extensive business intelligence efforts found in the corporate world and will develop new integrated solutions within the learning environment as one takes advantage of the LMS, SIS, and other emerging tools.[26]

Building Organizational Capacity for Analytics

The seven types of actions/processes deployed to optimize student success discussed in the previous section required each institution to develop its organizational capacity along several

[25] Joyce C. Romano and Bill White, "Valencia College: LifeMap and Atlas—Planning for Success," *Game Changers*, 331.
[26] Linda Baer and John Campbell, "From Metrics to Analytics, Reporting to Action: Analytics' Role in Changing the Learning Environment," *Game Changers*, 57.

important dimensions. Accelerating the targeted development of organizational capacity for analytics is a promising strategy for enhancing student success and institutional effectiveness.

Most conversations in universities about data, information, reporting, and analytics begin with a focus on enterprise technology and tools for reporting and analysis. These elements are necessary, but not sufficient to the ultimate success of institutions in using analytics to optimize student success. The truly strategic issue facing higher education today is not just the availability of particular tools, applications, and solutions: It is the ability of individual institutions and the higher education industry as a whole to deploy/acquire in a purposeful and continuous manner the *full set of organizational capacity and behaviors needed to optimize student success*.

The Interconnected Elements of Organizational Capacity

In the aforementioned *Winning by Degrees*, McKinsey's Education Practice assessed the operational drivers of degree productivity to determine what makes some institutions more productive while preserving quality and access.[27] The specific actions to improve degree completion revolved around defining standard metrics and practices, mapping interventions, communicating a common set of facts, understanding how data is used to improve the system, and providing transparent public access to the data. Figure 9 portrays the three elements that McKinsey found were essential in enabling the strategies for highly productive performance.

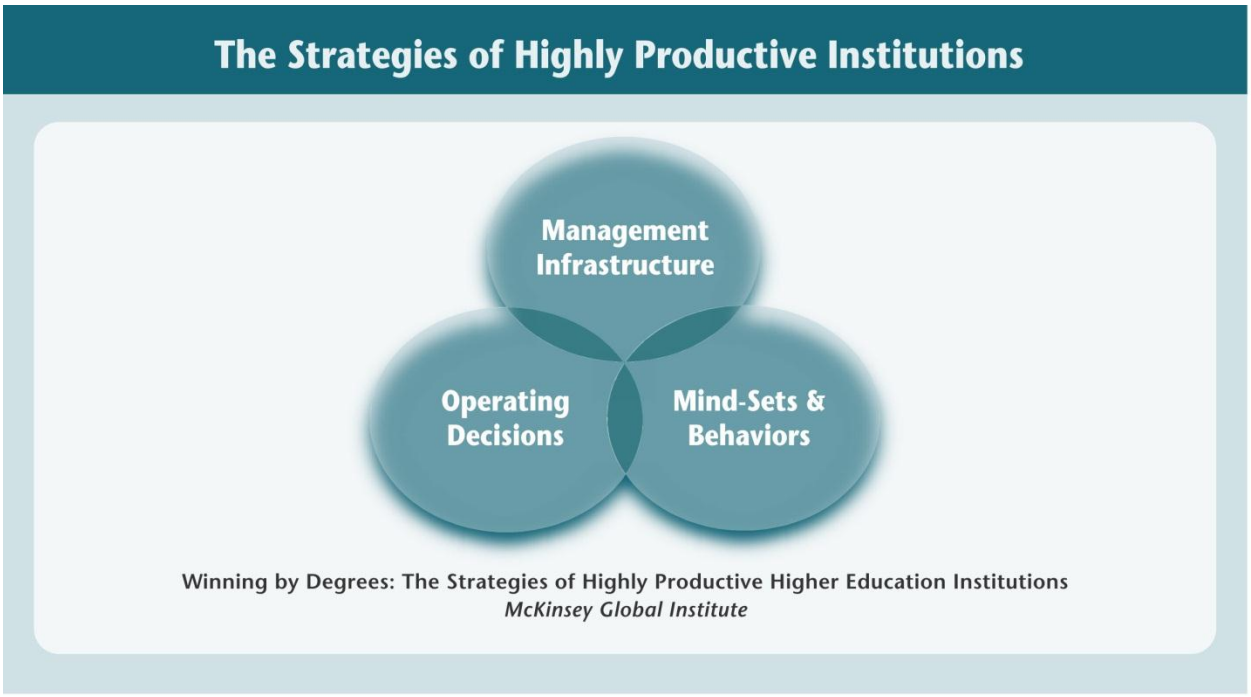


Figure 9. Strategies of highly productive institutions

[27] Auguste et al., *Winning by Degrees.*

In assessing the activities and processes that leading institutions used to optimize student success, we found they depended on a combination of five factors of organizational capacity, represented in figure 10 and described below.

Figure 10. Organizational capacity for analytics

- **Technology infrastructure, tools, and applications (IT intensity and ease of data capture, plus data availability)** comprise the basic enterprise technology environment for individual institutions, including the combination of data, information, reporting, and analytics capabilities. These include analytics tools, applications, services, and solutions provided to institutions by a constellation of technology vendors, consulting organizations, professional societies, communities of practice, and open resource offerings. The critical component is having a structure that enables users to access data to improve decision making.
- **Policies, processes, and practices (data-driven mind-set incorporated in processes)** to support the optimization of student success consist of the routinized processes and workflows to leverage all of the analytics, actions, and interventions needed to address at-risk students, at-risk behaviors, and learners' personalized learning needs. To be effective, these processes and practices need to be embedded in the fabric of institutions and used effectively by all faculty, staff, and students. Campuses should perform a policy, processes, and practices audit to see what supports student success and what has become an impediment.
- **Skills of faculty, staff, students, and other stakeholders (talent)** and their willingness to participate in coordinated, continuous attention to student success are part of a culture of performance. These skills include not just the ability to use automated support processes for

student success but also the willingness to embed these processes and practices in daily work. There are a few examples in analytics and data usage, of course. North Carolina State University has an Analytics Center. David Wiley teaches courses in analytics at Brigham Young University School of Education. And George Siemens at Athabasca University has been teaching an online course with plans to build a certificate or degree in analytics. Training needs are set to explode.

As institutions move to more cloud-based applications (software as a service, vendor provided), the vendor environments for technology, processes, and even skills become an extension of the institutional environment, augmenting institutional capacity in new ways.

- **The culture and behaviors (data-driven mind-set)** of institutions must change to optimize student success. This component is one of the most critical to building sustainable institutional change. Most institutions are in the process of migrating from a "culture of reporting" to a "culture of evidence," where analytics provide actionable intelligence that provokes actions and interventions to address at-risk students and at-risk behaviors. A further change is needed to effect a "culture of performance," where faculty and staff actions that optimize student success are not just encouraged but orchestrated and measured, with a focus on continuously improving results.
  - Culture change is demonstrated through changed behavior. Current applications of student success processes demonstrate that behaviors can be changed with the right solutions, processes, practices, and incentives, which can yield demonstrable results. These elements are necessary for faculty, staff, and students to invest their effort and change established patterns of behavior.
  - In addition, higher education needs to embrace the power of the value of data. This is done through creating transparency; enabling experimentation to discover needs; exposing variability and improving performance; segmenting populations to customize actions; building automated algorithms where they can support decision making for improving student success; and innovating through new business models, products, and services.[28]
- **Leadership at the institutional level (talent and mind-set)** is essential to optimizing student success. Few institutions make substantial progress in elevating the importance of analytics-supported student success initiatives without executive commitment to investing in new tools, solutions, and practices and especially in changing the culture and behaviors. A human and fiscal resource investment plan must be developed and must include a long-term commitment to launching, resourcing, scaling, and sustaining the effort.

[28] Manyika et al., *Big Data*.

University of Maryland, Baltimore County, and Rio Salado College stand out. UMBC's executive commitment is described both in our survey and in an article in *EDUCAUSE Review*.[29]

Several national and international organizations are featuring analytics for higher education leaders, including AIR, EDUCAUSE, and AASCU. SoLAR is a new organizational entity developed as the Society for Learning Analytics Research to advance research and practice in this emerging field.

At the federal level, the U.S. Department of Education's Office of Educational Technology issued a paper that suggests a range of recommendations to improve the use and application of educational data mining by educators, researchers, and developers.[30]

Organizational capacity building for analytics is more than the implementation of a new toolset project; it is the execution of a major change management program. Organizational capacity building is a campaign involving years of serious, progressive organizational development that changes culture, behaviors, and incentives.

The 40 leading institutions included in our survey are demonstrating the development of these different elements of organizational capacity. Similarly, the vendor tools, applications, solutions, and services described in our survey have been progressively expanding to include not only technology but also processes, practices, policies, and skill building. Still, significant "capacity gaps" have been revealed by our preliminary analysis, as summarized below. These will be expanded as the research findings are explored in greater detail.

Figure 11 illustrates the summary of organizational capacity for analytics for the American Public University System; figure 12 provides such a summary for Sinclair Community College. We plan to develop similar templates as part of our case studies for all 40 universities.

Initiatives to Accelerate Capacity Building for Student Success

Figure 13 is a bridge between this report and our larger work, *A Toolkit for Building Organizational Capacity for Analytics in Higher Education*. It examines the five vectors of organizational capacity for student success using two lenses: (1) the significance of the category and (2) potential initiatives to accelerate capacity building. These means for accelerating capacity for analytics will be explored in greater detail in the toolkit.

[29] Freeman A. Hrabowski III, John J. Suess, and John Fritz, "Assessment and Analytics in Institutional Transformation," *EDUCAUSE Review* 46, no. 5 (September/October 2011), http://www.educause.edu/ero/article/assessment-and-analytics-institutional-transformation.

[30] Bernadette Adams, "Enhancing Teaching and Learning through Educational Data Mining and Learning Analytics: An Issue Brief" (Washington, DC: Office of Educational Technology, U.S. Department of Education, April 10, 2012), http://evidenceframework.org/wp-content/uploads/2012/04/EDM-LA-Brief-Draft_4_10_12c.pdf.

Summary: American Public University System

Category	Current Status	Future Actions
Technology Infrastructure, Tools, Applications, and Consulting Services	APUS has a robust enterprise technology architecture and analytics applications. These applications are a mash-up of vendor-built software apps and analytics/BI tools, custom-developed analytics and modeling applications. APUS uses SPSS Modeler as its primary engine that gives the capability to do calculations. All APUS calculations are custom developed. APUS built their own model using regression analysis and line models that are pushed from an XML stream to Tableau. Data is extracted using sets of tools, mostly open source, from a federation of multiple databases into a middleware repository that is acted upon using Modeler. APUS anticipates moving to the IBM decision management tool when it is available.	APUS is pursuing the following improvements: • More granular data in LMS and other sources, • Personalized learning pathways, • Latent class analysis (LCA), • Improved modeling tools and applications, and • Cross-institution federated data mining, employability, and workforce data.
Policies, Processes, Practices and Workflows	APUS has mature policies, processes, practices, and workflows with retention and student success as clearly articulated processes. KPIs and dashboards reach everyone from executive to front-line employees. APUS has active or developing analytics processes in the following seven workflows: • **Manage the Student Pipeline** – Assess and manage the student pipeline with analytics; • **Eliminate Structural/Policy Impediments to Student Success** – strong focus on gateway courses; • **Dynamic Query, Drill-Down, and Intervention for At-Risk Behavior** – extremely active, embedded predictive analytics-driven; • **Active LRM** – Examine every learner, every week, ranked on risk of failure to succeed; Working to link to personalized learning; • **Personalized Learning Environments and Learning Analytics** – Adapting Adobe Omniture and Insight Catalyst for individual learner pathway analysis; • **Large-Scale Data Modeling** – uses data mining in current analytics. In addition, the PAR project with WICHE is creating a large-scale data set engaging over 800,000 students; and • **Employability and Workforce Issues** – as part of federal reporting on gainful employment, employability and workforce data are an important future focus.	APUS is pursuing the following improvements: • Capture more granular data for gateway courses; • Create developmental courses with embedded predictive analytics; • Expand latent class analysis (LCA), mapping test cases to look at content and activity to determine if it aligns with goals and objectives; • Extend cross-institutional data mining through PAR project; and • Generate employability and workforce data on APUS students and graduates, building into the future.
Values and Skills – All Stakeholders	Contributing to the optimizing of student success is a basic organizational value and part of the APUS business model. APUS has a highly skilled cadre of power users who develop models and data used by front-line users.	APUS is continuously improving the already high analytics skills of its core cadre of analytics staff and the end users who rely on a continuous flow of data, reports, and analysis.
Culture and Behavior	APUS demonstrates a culture of "performance measurement and improvement" and the behaviors that back it up.	APUS continuously refines its performance culture and behaviors.
Leadership	APUS has been a leader among the non-profits in making analytics a strategic imperative. Stage of Student Success Analytics: Level 3 – Optimization	APUS continues to improve its analytics capacity including cutting-edge advances in personalized learning pathways and analytics.

Figure 11. Summary of the American Public University System

Summary: Sinclair Community College

Category	Current Status	Future Actions
Technology Infrastructure, Tools, Applications, and Consulting Services	*Sinclair Community College has been building its analytics capacity for nearly 10 years. It created an 11-person Business Intelligence Competency Center, merging three units. It utilizes a holistic advising, case management and intervention system (8 years in the making) for at-risk and on-line students (student Success Plan – SSP). Its technology infrastructure is a robust ERP/LMS/DW/ETL/OLAP/B/ CRM – SP. Data Analysis Warehousing Intelligence Portal (DAWN) plus My Academic Plan – SPS. Sinclair is a reference account for SAS.*	*Sinclair is pursuing the following improvements:* • *Data visualization in a simplified fashion; and* • *Enhance metadata functions that track where data comes from and how it evolves.*
Policies, Processes, Practices and Workflows	*Sinclair Community College has mature but evolving policies, processes, practices and workflows for retention and student success as clearly articulated processes. Sinclair has active or developing analytics processes in the following workflows:* • ***Manage the Student Pipeline*** *– Assess and manage the student pipeline with analytics;* • ***Eliminate Structural/Policy Impediments to Student Success*** *– Strong focus on first-year experience, student success planning in English and Math;* • ***Dynamic Query, Drill-Down and Intervention for At-Risk Behavior*** *– Dynamic query and drill-down are not universally available but capability is being developed; first generation predictive analytics; Student Success Plan provides intervention;* • ***Active LRM*** *– Student Success Plan (SSP) Case Management and Intervention System provides faculty and staff a holistic advising support too; currently used for dealing with at-risk students, on-line students, and high school students; it is being expanded to open source; My Academic Plan uses CESSE and NSSE assessment data to provides prescriptive degree pathway planning;* • ***Personalized Learning Environments and Learning Analytics*** *– Just started doing institution-wide assessments of student learning in the classroom;* • ***Large-Scale Data Modeling*** *– Use data mining in current analytics to predict which critical introductory courses have students most likely to struggle and offers help; but not large-scale or cross institutions/sector; and* • ***Employability and Workforce Issues*** *– Hooks are in place for linkage to workforce issues.*	*Sinclair is pursuing the following enhancements:* • *Converting SSP to open source and sharing with other institutions; community of practice;* • *Expanding predictive analytics beyond initial uses – pilot project in Management 105 to predict student success should be expanded;* • *Plan to incorporate wage data from Ohio's Department of Job and Family Services so that we can show a link between paying tuition leads to economic growth and better jobs for the Dayton Region.* • *More actively use keystroke analysis and other unobtrusive measures to predict student success;* • *Need to expand utilization of My Academic Plan and SPS capabilities; and* • *Productize best processes practices and spread to other institutions.*
Values and Skills – All Stakeholders	*DAWN portal puts data in the hand of end users without involving intermediaries. SSP is available to advisers.*	*Sinclair is seeking more human capital talent to operate the tools and clearly articulate the results – raising skills requirements.*
Culture and Behavior	*Sinclair displays a culture of Evidence-Based Decision Making, on the verge of a Culture of Performance Measurement and Improvement.*	*Need to extend the performance measurement and improvement culture and behaviors into the classroom.*
Leadership	*Campus leadership has been actively supportive of Data Warehouse initiative to create "a single version of the truth." President's Cabinet involved in setting goals and targets for KPIs.* *Stage of Student Success Analytics: Level 2 on verge of level 3.*	*Leadership is pushing for greater accountability and performance improvement through analytics.*

Figure 12. Summary of Sinclair Community College

Summary of Initiatives to Accelerate Capacity Building for Student Success

Category	Significance of Category	Initiatives to Accelerate Capacity Building
Technology Infrastructure, Tools, Applications and Consulting Services	• Selecting new technology is often the catalyst for starting a fresh student success initiative. • But technology alone is only part of the answer. It is necessary, but not sufficient. • Technology for analytics includes the combination of ERP, LMS, Analytics Apps (DW, ETL, OLAP, BI), CRM/Advising, and various Software Solutions.	• Stage institutional/solution provider dialogues to encourage new generations of tools, applications, and services in core systems – ERP, LMS, analytics, visualization • Provide match-up services and FAQs so striving institutions can see what comparable institutions are doing in analytics and help them make selections. Provide case studies from comparable institutions. • Hosted solutions are a way for institutions to accelerate analytics progress – they can use solution providers to acquire technology, processes, workflows, and talent and reduce time to achieve analytics. • Facilitate collaboration and sharing of services, solutions, models, and such – institutional consortia, federated solutions, solution provider client communities, productizing of best processes.
Policies, Processes and Practices	• Policies, processes, workflows, and practices are essential for student success analytics. • Two processes/workflows are the focal points for making a leap in analytics: Embedded Predictive Analytics and Learner Relationship Management.	• Use case studies and best practices from leading institutions – policies, processes, practices • Encourage sharing, copying, and productizing of policies, processes, and workflows (establish clearinghouse services) • Collaborate on and share successful workflows for student success and predictive model components – adopt successful technologies/workflows with minor changes. Productize best processes.
Values and Skills of Faculty, Staff, Students, and Other Stakeholders	• Skill-building and consciousness-raising are critical • Utilize **A Toolkit for Building Organizational Capacity** to develop individuals, teams, and institutions. • Over time, the cognitive complexity of college and university staff will need to increase for the new analytics-rich work environments • Taken together, skills, culture and leadership are the most challenging elements of capacity building and take the most time	• Provide developmental and training materials for students to take ownership of their data, learning pathways, and personal learning experiences • Leverage existing training in analytics in academic settings – North Carolina State, BYU, others • Leverage roles of professional associations – train the trainers, raise analytics IQ, create communities • Provide consultation and training at the campus level • Form collaborations/consortia to share highly skilled analytics talent • Create new job descriptions and higher levels of skill for staff – new breed of analytical staff – target key areas in institutions
Culture and Behavior	• Changing culture and behaviors is of paramount importance and takes time • Need to evolve from a culture of reporting to a culture of evidence to a culture of performance measurement and improvement.	• Use case studies and assessments of success stories in changing culture/behaviors in different institutional settings • Incentives from trustees and governing boards, performance incentives for individuals • Provide on-the-ground examples of modeling new behavior and expand across the institution
Leadership	• Leadership needs to elevate analytics for student success to become a strategic imperative.	• Use leadership case studies of student success initiatives • Embed this topic in leadership development activities of professional associations – EDUCAUSE, AASCU, AACC, AGB, NAICU

Figure 13. Summary of initiatives to accelerate capacity building for student success

Insights on the Current State of Organizational Capacity for Analytics

We have used our conversations with representatives of leading institutional analytics practitioners and vendors to develop some preliminary insights on the state of practice and organizational capacity for analytics in higher education. The focus has been on how to optimize student success and institutional productivity and what organizational capacity is needed to do so. Our insights will be refined through further conversations and expansions of the set of vendors.

Insights from Leading Practitioners

Our cohort of leading-edge practitioners has demonstrated that analytics can be leveraged to effectively support student success practices in a wide range of institutional settings: for-profit and primarily online universities, comprehensive universities, private colleges and universities, community and technical colleges, and systems of institutions. Many of these practitioners have established a strong ROI on student success analytics, the killer app for analytics. For example:

- The for-profit universities have improved performance and retention through their analytics: American Public University, University of Phoenix, Capella University, and Kaplan University–Online.
- Arizona State University has improved its retention rates by 4–5% through leveraging Sun Devil Tracking and eAdvisor.
- By comparing Signals-informed courses with non-Signals courses, Purdue University estimates it has improved retention in Signals courses by 20% and four-year degree completion rates by 4%. Purdue has several partner universities and colleges collaboratively expanding this toolset across the country.

Many institutions have a multilevel focus for analytics. Many of our leading institutions are using analytics in all seven of the categories in the Norris/Baer framework (see figure 8): managing the pipeline, eliminating success barriers, embedding real-time analytics and interventions for at-risk behavior, leveraging LRM systems, developing personalized learning systems and learning analytics, elevating data mining, and extending capacity to include employability/workforce analytics. Leveraging these seven categories of student success analytics will require new levels of organizational capacity for analytics. Even our leading practitioners plan to extend the scope and scale of their analytics activities and raise the level of best practice in all these categories over time.

The current focal points for analytics are *dynamic, predictive analytics* and *leveraging LRM systems*. These two elements are decisive in moving institutions to higher levels of institutional commitment.

Vendors provide new tools and solutions. Over the next few years, leading practitioners expect new analytics and big data tools now in development by vendors to substantially enhance the state of practice for analytics. Many of these enhancements will be available for inclusion in existing enterprise ecosystems and/or will be embedded in ERP/LMS offerings in the cloud. Others will be incorporated in parallel, concurrent, free-range learning experiences that will need to be certified by institutions giving credit for prior learning.

Today and for the next few years, the primary focal point for impactful analytics applications is Levels 3 and 4 of the Norris/Baer framework. The embedding of predictive analytics and dynamic intervention into academic processes and the elevation of advising systems to first-generation LRM systems is a key development.

Within the next 3–5 years, however, personalized learning networks and related learning analytics (Level 5) will emerge as critical developments. These will open up and transform learning in institutions and among free-range learners. At the same time, institutions will be deploying big data applications (Level 6) and forensically discovering the secrets of student success. Workday, for example, has just announced the deployment of a big data application.

Finally, the extension of the concept of student success from pre-K–20 through school-to-work transitions and career success (Level 7) will grow in importance over the next few years. Analytics applications to serve these needs will emerge in the near future, creating new service lines for current learning providers and supporting technology solution providers.

The emerging core systems environment of the future will look different. The selection of analytics tools, applications, and solutions is not occurring in a vacuum. It is part of the larger question: What will the core systems environment of institutions look like in the emerging Web 3.0 future? All institutions are scrutinizing their existing ERP, LMS, and ancillary systems looking for solutions that are more affordable, open, and capable. The enhancement of analytics capacity, including next-generation learning analytics at the class/course level, is another item on that list. Cloud computing will be an important element of the future solution. Consequently, CIOs and institutional executives are looking for assured migration paths to new environments likely to be very different from today's.

Most large institutions are taking a multiple-vendor, mash-up approach to analytics. There is a strong sense that the field is in a state of flux and thus that multivendor strategies are prudent. It is interesting to track the accumulation and integration of analytics capabilities over time. In addition, most of the leading large institutions have completed considerable in-house development and customization of analytics capabilities.

Commitment and leadership from the president and provost are critical for student success efforts to become true enterprise initiatives. This is especially true if culture and behaviors must change in order to consistently and pervasively pursue student success practices across the institution. As already stated, the for-profit institutions have largely achieved enterprise-wide commitment to pervasive student success practices and behavior change. In addition, a number of our leading not-for-profit institutions have demonstrated strong executive commitment: UMBC and Rio Salado College stand out. UMBC's executive commitment is described both in our survey and in the *EDUCAUSE Review* article "Assessment and Analytics in Institutional Transformation."[31]

Sharing of ideas and know-how among leaders is increasing. Five years ago, for-profit universities were highly circumspect about their analytics. Today, they are more open to

[31] Hrabowski et al., "Assessment and Analytics in Institutional Transformation."

sharing best practices, potentially becoming suppliers or partners to other institutions attempting to raise their analytics IQ. In this regard, many of our for-profit institutions may be both "institutional practitioners" and "vendors" to other institutions over time. Such approaches might be essential to building the organizational capacity of analytics across the entire higher education industry.

Good news and bad news combine. The good news from these examples is that some institutions have found ways to pioneer student success solutions, demonstrate ROI, and set their sights on the next steps in analytics development. The bad news is that the current generation of tools, applications, solutions, and services is still in the "early days" and in need of enhancement. However, more advanced offerings are in the works as part of the larger strategic move to create the next generation of core systems that are more affordable, more open, and more capable.

Insights about Solution Provider Offerings and Strategies

Over the past year, many higher education solution providers have made substantial strides:

- Across the board, there is a clear, expanded emphasis on analytics. New functionalities, applications, solutions, and consulting services are available from ERP and LMS solution providers offering student success/retention solutions.
- New firms offering student success/retention solutions are gaining traction in the market. Also, ERP and LMS providers are marketing student success/retention solutions.
- In addition, new vendors with an analytics twist have emerged in many categories. In addition to retention and student success solutions, these include personalized learning solutions and applications in the K–12 and workforce sectors that have potential applicability to higher education.
- Acquisitions and consolidations have continued: Blackboard acquired iStrategy and embedded its prepackaged analytics applications into an expanded Blackboard Learning offering that can extract data from major ERP systems and the Blackboard LMS; SunGard productized Course Signals from Purdue; and the consolidation of SunGard and Datatel into Ellucian will have implications for the marketplace.
- New LMS alternatives with embedded analytics are proliferating, both as open source and in the cloud: Instructure/Canvas, LoudCloud, Moodlerooms, and others.
- Consulting services are becoming a more significant component of analytics offerings for many vendors; these services go beyond implementation to focus on know-how in leveraging analytics solutions to advance retention and student success.
- A number of cloud-based analytics applications and services demonstrate the cloud's potential to leverage vendor infrastructure, solutions, processes, cross-sector linkages, and know-how. Pearson/eCollege is achieving some especially interesting outcomes in this area, conducting analytics across its constellation of cloud-based clients.

- The need for improved visualization, recognized by many vendors, is being incorporated in next-generation tools. (We will want to explore what the IBM and Desire2Learn partnership means.)

As more becomes known about analytics, the features, functions, and limitations of existing and promised offerings are being scrutinized more fully and effectively. Strong marketplace incentives for continuing vendor innovations are pushing the envelope of application.

Cost and affordability are key issues. Consideration of new analytics applications is linked with reevaluation of LMS strategies and the new options (OpenClass) in that area, such as those announced recently by Pearson and Google. More will be written about insights from vendors as we complete the vendor interviews and expand the number to include new entries to the field.

Insights about Higher Education in General

We also asked solution providers about their impressions of higher education in general, based on their efforts to engage the full range of institutional leaders on analytics. Their feedback resonated with the experiences of our research team in engaging institutions about the potential of analytics.

The "analytics IQ" of rank-and-file leaders in higher education is not high. Or, more typically, it lags behind the new and rapidly accelerating developments in the analytics field. Many institutional leaders overestimate their enterprise's capacity in data, information, and analytics capacity. Many do not fully appreciate the change management challenges facing their institutions if they are to fully embrace the embedded deployment of performance-focused analytics.

We found substantial need for raising professional development, capacity building, and the analytics IQ of institutional leadership and practitioners, at all levels. This is a significant challenge and opportunity.

Affordable solutions are needed. In spite of this, the need for affordable analytics solutions—ones that deliver student success–based ROI—is articulated by institutional leadership. The bar keeps rising for analytics possibilities as new analytics applications and solutions emerge. The use of big data in other industries is entering the public consciousness, and institutional leaders are feeling the strong push for accountability and demonstrations of performance.

Student success analytics is perceived as critical to responding to such accountability pressures, and productivity analytics also are likely to receive substantial attention.

Stages of Student Success Analytics

In putting together the insights from our research, we concluded that it was useful to characterize the current status of organizational capacity for analytics in higher education as three stages of development (portrayed in figure 14).

- **Level 1: Static Reporting.** Leadership focus is on data and reporting:
  - a culture of reporting
  - basic ERP/LMS/report writing tools
  - first ventures into analytics tools and applications
  - analytics for power users
  - leadership is exploring ways to make the leap to Level 2

  Level 1 includes most of higher education—approximately 3,000+ institutions. These institutions are seeking guidance on how to improve their organizational capacity and accelerate their uptake of student success analytics.

- **Level 2: Dynamic Analysis and Intervention.** Leadership focus is on supporting evidence-based decision making:
  - an emerging culture of evidence-based decision making
  - a combination of ERP/LMS/mashups of analytics applications
  - more advanced data governance
  - many shared/federated solutions
  - first-generation embedded predictive analytics and LRM systems
  - improved retention and advising systems
  - analytics for the masses—training and professional development
  - leadership is exploring how to make the leap to Level 3

  Roughly 800–900+ institutions have achieved most of the characteristics we associate with Level 2 institutions, and an equal number have progressed substantially along this migration path. Many of these institutions are using shared or vendor-hosted solutions to accelerate their development and advancement.

- **Level 3: Optimization.** Strong, committed leadership makes analytics a strategic imperative for the institution:
  - an emerging culture of performance measurement and improvement
  - mature predictive analytics and LRM
  - over time, link to new developments in learning analytics, big data, and workforce analytics
  - pervasive analytics for everyone—elevates job descriptions
  - leadership focuses on optimizing student success and institutional effectiveness using analytics

  Approximately 30–50 institutions have fully achieved Level 3 status, although even the leaders recognize that much work remains to achieve optimization. The leading analytics institutions are mostly for-profits and primarily online institutions.

In our observation, it usually takes most institutions 2–3 years to advance from Level 1 to Level 2 once leadership commits seriously to enhancing analytics, and another 3–5 years to advance from Level 2 to Level 3. It took many of the leading institutions 7–10 years to develop their current level of analytics, but they were developing applications and capacity from scratch. Today's institutions have the benefit of best practices and models to guide them. Moreover,

interventions can accelerate their transitions and improve success rates, thereby reducing the analytics capacity gap in higher education. While these characterizations are not ironclad rules, they do suggest logical progressions that institutions can follow to enhance their analytics standing.

Stages of Student Success Analytics (SSA/LRM)

Characteristics	Level 1: Static Reporting	Level 2: Dynamic Analysis and Intervention	Level 3: Optimization
Nature of Reporting, Query and Analytics (Davenport/ Harris)	Reporting	Reporting/Query/Intervention/ Forecasting/Predictive Analytics	Reporting/Query/Intervention/ Forecasting/Predictive Analytics **Plus Optimization**
Building Organizational Capacity			
1 Technology Infrastructure, Analytic Tools and Applications	• Basic ERP, LMS, Report Writing Tools • First Ventures into Analytics Tools and Applications	• Combination of ERP, LMS, Analytics Applications (Data warehouse, ETL, OLAP, BI, Visualization, CRM and Advising). Mashups of Applications • A Range of Outsourced and Collaborative Solutions (Hosted, Federated Solutions, Consortia)	• Sophisticated, Multi-Data-Source Data Warehouses with Sophisticated Analytic Capabilities • Extensive Dashboarding, Visualization, Covering all Aspects of Student Success and Other Performance Metrics
2 Policies, Processes, Practices, and Workflows	• Awash in Non-integrated Data – Data "Hiding in Plain Sight" • Basic Policies for Data Governance/Stewardship and Student Articulation • Basic Analytics in SEM and Eliminating Barriers to Success	• First Generation Predictive Analytics and Learner Relationship Management (LRM) Solutions • Improved Data Governance and Stewardship • Improved Retention and Advising Processes and Workflows – Outsourced, Homegrown, Shared/Licensed	• Mature Predictive Analytics Embedded in Processes and Mature LRM • Advanced Data Stewardship, Extended to More Data Sources • Over Time, Predictive Analytics/LRM Link to New Developments in Personalized Learning, Learning Analytics, Data Mining, and Workforce Analytics
3 Values and Skills – Faculty, Staff, Students, and Other Stakeholders	• Power Users Provide Reports for Users	• "Analytics for the Masses" Creates Need for Broader Skills in Analytics Use • Training and Professional Development in Using Analytics, Changing Culture	• Pervasive Analytics Engages Everyone • Changing Job Descriptions, Greater Cognitive Complexity Required for Staff
4 Culture and Behaviors	Culture of Reporting	Culture of Evidence-Based Decision Making is Reflected in Behaviors	Culture of Performance Measurement and Improvement Pervades the Institution
5 Leadership	Leadership Focus on Data and Reporting	Strong Leadership to Support Evidence-Based Decision Making	Strong, Consistent Leadership to Make Analytics a Strategic Imperative
Number of Institutions in this Category	Approximately 3,000+ Institutions	Approximately 800-900 Institutions	Approximately 30-50 Mostly For-Profits and Online Universities
Time to Achieve Jump Shifts	2-3 Years from Level 1 to Level 2	3-5 Years from Level 2 to Level 3	Continuous Improvement and Expand SSA to Include New Elements
Potential Impact of Interventions	Increase Numbers Making Leap to Level 2, Accelerate Time Frame, and Improve Success Rates	Increase Numbers Making Leap to Level 3, Accelerate Time Frame, and Improve Success Rates	Enable Leading Institutions to Share and Productize their Best Practices, Products, and Services

Source: Adapted from "A New Age of Learning Management Analytics" Moodlerooms Collateral, Louis C. Pugliese.

Figure 14. Stages of student success analytics

Describing the Current Analytics Capacity Gap

Put simply, a significant analytics capacity gap exists in higher education, encompassing all of the elements of analytics capacity—technology, processes/practices, skilled people, culture/behaviors, and leadership. This mirrors the findings of the McKinsey Global Institute in its May 2011 report on big data, which found substantial gaps in other industries—health care in the United States, the public sector in Europe, retail in the United States, and manufacturing and personal location data globally.[32]

Especially telling, there is a talent gap in analytics-experienced professionals and difficulties in hiring both specialized and general analytics talent. This includes skills and competences in the technical aspects of analytics and big data and know-how in changing institutional processes, workflows, cultures, and behaviors to a performance orientation.

Moreover, the pervasive need for professional development at all levels calls for concerned action by individual institutions and the industry. These developmental experiences must move far beyond traditional tools training to address organizational and behavioral change. They must also develop the capacity to leverage analytics to improve student success, broadly defined, and productivity/institutional effectiveness.

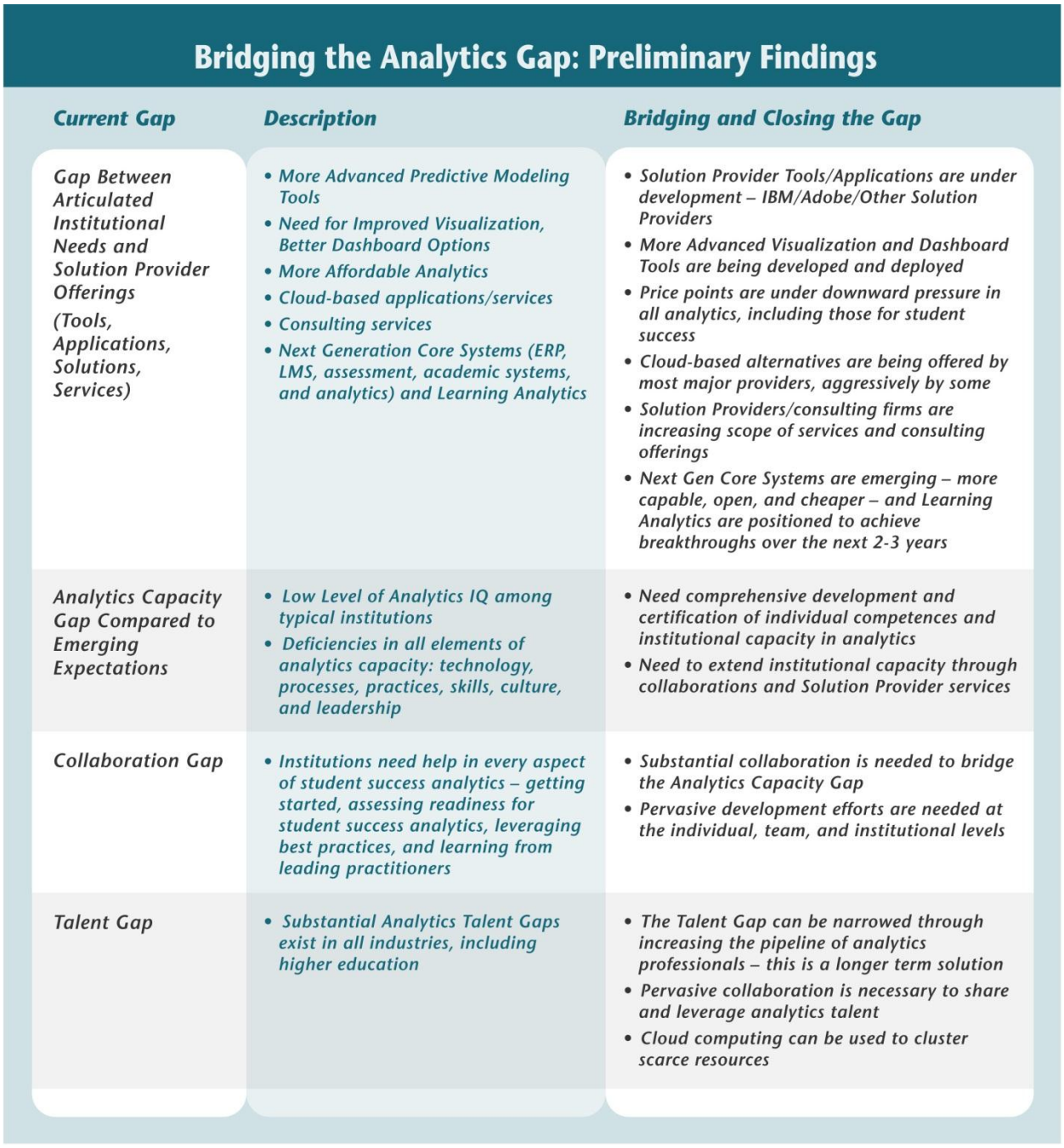
Figure 15 summarizes our preliminary findings on perspectives and actions needed to bridge the analytics capacity gap. We cite four manifestations of the gap that need to be filled and the classes of actions needed to fill them:

- Gap between institutional needs and vendor offerings
- Gap between current analytics capacity and expectations
- Collaboration gap
- Talent gap

While the magnitude of the gap between current capacity and expectations is substantial, there are positive notes.

The first generation of analytics tools and applications needs upgrading, and help is on the way according to reports of new products in the development pipeline, with more to come. New providers are appearing all the time, with different perspectives and techniques honed in other sectors—health care, financial services, commercial applications, K–12, and corporate- and workforce-focused learning. In addition, technology vendors, consulting firms, and other providers are accelerating their efforts to provide not just implementation support but also strategic consulting, process and workflow support, and guidance on leveraging analytics to improve performance. These are developments to watch carefully.

[32] Manyika et al., *Big Data*.



Bridging the Analytics Gap: Preliminary Findings

Current Gap	Description	Bridging and Closing the Gap
Gap Between Articulated Institutional Needs and Solution Provider Offerings (Tools, Applications, Solutions, Services)	• More Advanced Predictive Modeling Tools • Need for Improved Visualization, Better Dashboard Options • More Affordable Analytics • Cloud-based applications/services • Consulting services • Next Generation Core Systems (ERP, LMS, assessment, academic systems, and analytics) and Learning Analytics	• Solution Provider Tools/Applications are under development – IBM/Adobe/Other Solution Providers • More Advanced Visualization and Dashboard Tools are being developed and deployed • Price points are under downward pressure in all analytics, including those for student success • Cloud-based alternatives are being offered by most major providers, aggressively by some • Solution Providers/consulting firms are increasing scope of services and consulting offerings • Next Gen Core Systems are emerging – more capable, open, and cheaper – and Learning Analytics are positioned to achieve breakthroughs over the next 2-3 years
Analytics Capacity Gap Compared to Emerging Expectations	• Low Level of Analytics IQ among typical institutions • Deficiencies in all elements of analytics capacity: technology, processes, practices, skills, culture, and leadership	• Need comprehensive development and certification of individual competences and institutional capacity in analytics • Need to extend institutional capacity through collaborations and Solution Provider services
Collaboration Gap	• Institutions need help in every aspect of student success analytics – getting started, assessing readiness for student success analytics, leveraging best practices, and learning from leading practitioners	• Substantial collaboration is needed to bridge the Analytics Capacity Gap • Pervasive development efforts are needed at the individual, team, and institutional levels
Talent Gap	• Substantial Analytics Talent Gaps exist in all industries, including higher education	• The Talent Gap can be narrowed through increasing the pipeline of analytics professionals – this is a longer term solution • Pervasive collaboration is necessary to share and leverage analytics talent • Cloud computing can be used to cluster scarce resources

Figure 15. Bridging the analytics capacity gap—preliminary findings

Bridging the Analytics Gap: Needs, Solutions, and Next Steps

This research surveyed 40 leading institutional practitioners and 20 solution providers and has illuminated the state of analytics capacity and practices. It has also captured prospects for the future. The next steps in the project include the following:

- **Complete the interviews and meta-analysis.** We are still "cleaning up" and extending the interview data to incorporate new insights and frameworks derived from the preliminary analysis.
- **Bring selected institutions and solution providers together to explore bridging the gap and strategies for accelerating analytics development.** Based on our preliminary analysis, we will convene one or two small group meetings of vendors and institutional leaders to discuss how to bridge the gap and dramatically accelerate raising the analytics capacity in higher education.
- **Over time, extend the interviews to include other institutions/vendors (up to 40 or more); analytics vendors at the session will be invited to participate.** We are also looking to progressively extend the interviews to additional vendors and a few strategic institutional leaders.
- **Develop a plan for FAQs and match-up services for analytics solutions and services and fashion an active information marketplace.** The plans for such FAQ and match-up services have been developed. A tentative outline is contained in Appendix B.
- **Develop *A Toolkit for Building Organizational Capacity* plus training and certificate programs.** A plan for the toolkit has been developed, and writing is under way. The toolkit will align with the EDUCAUSE National Agenda for Analytics program, will draw on existing learning and capacity development from other sources, and will become the first set of electronic resources in what will be a substantial online resource.

  The toolkit may also be part of a learning and certification program, offered with the participation of professional associations such as EDUCAUSE, AASCU, AACC, AIR, SCUP, AACRAO, and others.
- **Actively accelerate the development of organizational capacity for analytics and emphasize the importance of cross-institutional collaborative efforts to build capacity.** The higher education industry cannot develop its organizational capacity for analytics without engaging in substantial collaboration, sharing of know-how, and creative approaches to the talent gap. This will include cross-institutional and even cross-sector collaboration. It will also include a significant expansion of the role of vendors and consultants as extensions of the organizational capacity of individual institutions and collaborative groups and consortia.

  Demonstrating how to accelerate the development of organizational capacity for analytics, at scale, is the signal challenge facing higher education on the verge of the age of big data. Tools, techniques, applications, and breakthroughs are being pioneered in other industries. Figuring out how to replicate these at scale to higher education (actually to K–20 and

learning/workforce) is the real challenge, requiring new paradigms beyond the individual campus model.

This project is closely aligned with other Bill & Melinda Gates Foundation–funded analytics initiatives, including the recently announced National Agenda for Analytics program with EDUCAUSE.

Appendix A: More on Definitions for Analytics

In "Analytics in Higher Education: Establishing a Common Language" van Barneveld, Arnold, and Campbell relate that analytics is

> [The] processes of data assessment and analysis that enable us to measure, improve, and compare the performance of individuals, programs, departments, institutions or enterprises, groups of organizations, and/or entire industries.[33]

They also discuss a plethora of terms and definitions.[34]

> Today's society is driven by data, as evidenced by the popular use of the term *analytics*. In some cases, the term may reflect specific topics of interest (health analytics, safety analytics, geospatial analytics), while in other cases, it may reflect the intent of the activity (descriptive analytics, predictive analytics, prescriptive analytics) or even the object of analysis (Twitter analytics, Facebook analytics, Google analytics). A variety of terms for analytics also exist in the educational domain. Higher education's approach to defining analytics is particularly inconsistent. In our review of the literature, we found that some definitions were conceptual (what it *is*) while others were more functional (what it *does*). This lack of a common language causes difficulty, both for institutional collaboration and for setting an agenda for the larger teaching and learning community."

And point out that

> Hawkins and Watson caution that analytics is not a one-size-fits-all endeavor and that one has to consider that analytics is a goal-directed practice. The objectives and information needs within higher education differ based on what needs to be known or predicted and by whom. Hawkins stated that "there is a substantial difference between the kinds of metrics and indicators that are meant to measure students' and consumer information needs." Along similar lines, Watson indicated that "analytics means different things to different people. There are very different kinds of analytics, and the differences have important implications for where they are used, who performs them, the skills that are required, and the technologies that are involved…be clear about what kind of analytics you are discussing."

To address these differences, we offer a view of the current landscape of terminology in use and bring to light the varied and overlapping definitions of analytics in the academic domain. Table A.1 contains a variety of definitions for terms seen in popular and research literature related to analytics. Based on the given definition, we have listed the term, the various definitions attributed to the term, and the level where the analytics are focused (e.g., analytics may be conducted at the level of the institution, the department, or the learner, depending on the goals and objectives of the analysis).

Van Barneveld, Arnold, and Campbell proposed a conceptual framework for positioning analytics within a business and academic domain (figure 1). Different data are used at different levels of the institution—for different analyses, for different reasons, by different people. While

[33] Van Barneveld, Arnold, and Campbell, "Analytics in Higher Education," 3.
[34] Ibid., 2.

they offer conceptually separate and distinct definitions for various types of analytics used in higher education (table A.1), we acknowledge that, functionally, the different analytics are intended to work as a cohesive and integrated whole that serves the needs of the academy at a variety of levels.[35]

Jacqueline Bichsel has written an excellent research report, *Analytics in Higher Education: Benefits, Barriers, Progress, and Recommendations*, for the EDUCAUSE Center for Applied Research. This report surveyed IT and IR professionals at several hundred institutions and provides a snapshot of current practices and potential future directions.[36] Several of these findings are contained in figures A2 through A4.

Finally, note that the table and figures in this appendix provide additional information about analytics definitions, areas of continuing concern, current status, processes, and elements of the toolkit.

[35] Ibid., 5.

[36] Bichsel, *Analytics in Higher Education*.

Table A.1. Conceptual and functional definitions

Conceptual and Functional Definitions of Various Types of Analytics

Term	Definitions	Level of Focus
Analytics	"[The] processes of data assessment and analysis that enable us to measure, improve, and compare the performance of individuals, programs, departments, institutions or enterprises, groups of organizations, and/or entire industries." [8]	• Institution • Instructor • Department • Learner
	Data-driven decision making, used to inform decisions at all levels of the enterprise.[9]	• Institution • Instructor • Department • Learner
Business Analytics	"The whole category is just using data and analysis to understand and manage your business more effectively, as opposed to simply capturing your customer's address or keeping track of your employees' vacation balances, that transactional kind of stuff."[10]	• Institution (enterprise)
	"Business Analytics (BA) is the practice of iterative, methodical exploration of an organization's data with emphasis on statistical analysis. BA is used by companies committed to data-driven decision making. BA is used to gain insights that inform business decisions and can be used to automate and optimize business processes. Data-driven companies treat their data as a corporate asset and leverage it for competitive advantage."[11]	• Institution (enterprise)
Academic Analytics	"Early academic analytics initiatives are seeking to predict which students are in academic difficulty, allowing faculty and advisors to customize learning paths or provide instruction tailored to specific learning needs."[12]	• Learner
	"[Focused] on academic issues, primarily student access, affordability, and success."[13]	• Learner
	"[The] imperfect equivalent term for Business Intelligence, which [essentially describes] the use of information technology to support operational and financial decision making."[14]	• Institution
	"[Marrying] data with statistical techniques and predictive modeling to help faculty and advisors determine which students may face academic difficulty, allowing interventions to help them succeed."[15]	• Instructor • Learner
	"Mining data from systems that support teaching and learning to provide customization, tutoring, or intervention within the learning environment."[16]	• Instructor • Learner
	"[A] process for providing [higher education institutions] with the data necessary to respond to the reportage and decision making challenges facing contemporary universities."[17]	• Institution • Department
	"[It] can refer broadly to data-driven decision making practices for operational purposes at the university or college level, but it can also be applied to student teaching and learning issues."[18]	• Institution • Learner • Instructor
	"[Can] identify and even predict students who may be at risk [in a particular course]."[19]	• Instructor • Learner
Learning Analytics—Academia	"[The] interpretation of a wide range of data produced by and gathered on behalf of students in order to assess academic progress, predict future performance, and spot potential issues."[20]	• Institution • Learner
	"[The] use of predictive modeling and other advanced analytic techniques to help target instructional, curricular, and support resources to support the achievement of specific learning goals"[21] (n.b. Bach presents learning analytics and academic analytics as synonymous concepts).	• Department • Learner
	"[To] enable teachers and schools to tailor educational opportunities to each student's level of need and ability."[22]	• Learner
	"It might be used as well to assess curricula, programs, and institutions."[23]	• Institution • Department
	"[The] use of data and models to predict student progress and performance, and the ability to act on that information."[24]	• Learner
	"[The] collection and analysis of usage data associated with student learning; [to] observe and understand learning behaviors in order to enable appropriate intervention."[25]	• Learner

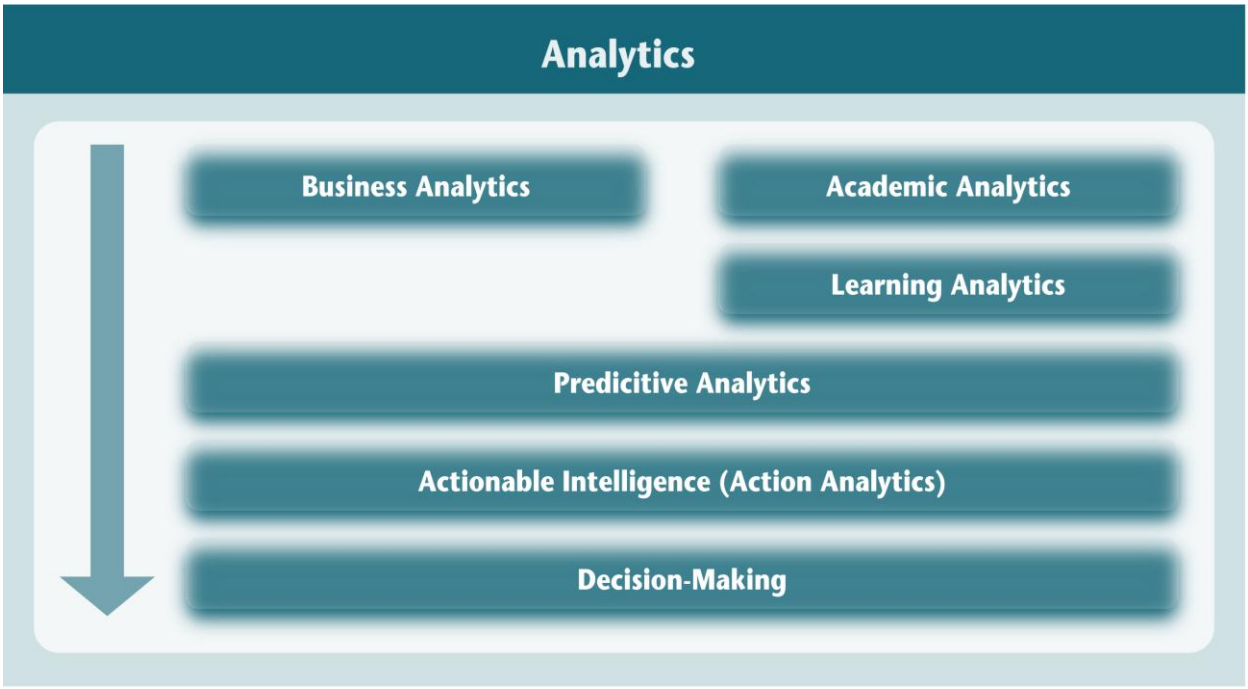
Continues...

Table A.1. *(continued)*

Conceptual and Functional Definitions of Various Types of Analytics

Term	Definitions	Level of Focus
Learning Analytics—Industry	*"[The] study of the impact of learning on its learners."*[26]	• Learner
	"[Gathering] input from multiple databases and, when conjoined with appropriate queries, can pull data and create a real-time slice of an organization's training metrics."[27]	• Institution • Department
	"[A] set of activities an organization does that helps it understand how to better train and develop employees and customers."[28]	• Institution • Department
Predictive Analytics	*"[A] set of [business intelligence] technologies that uncovers relationships and patterns within large volumes of data that can be used to predict behavior and events […] predictive analytics is forward-looking, using past events to anticipate the future."*[29]	• Institution • Instructor • Department • Learner
	"Predictive analytics connects data to effective action by drawing reliable conclusions about current conditions and future events."[30]	• Institution • Instructor • Department • Learner
	"Predictive analytics […] is both a business process and a set of related technologies. Predictive analytics leverages an organization's business knowledge by applying sophisticated analysis techniques to enterprise data. The resulting insights can lead to actions that demonstrably change how people behave as customers, employees, patients, students, and citizens."[31]	• Institution • Instructor • Department • Learner
Action Analytics	*"[More] comprehensive than academic analytics, encompassing academic and administrative processes, and recognizing the need for transformative reinvention and reimagining […] focused more broadly on academic and administrative productivity and performance."*[32]	• Institution
	"The term action analytics refers to analytics capabilities and practices that are powerful, immediate, and useful to a wide variety of stakeholders. But most importantly, action analytics can only happen in enterprises and environments that are genuinely committed to measuring and improving key aspects of productivity, innovation, and performance. These organizations must actively build the capacity and cultivate the behaviors to do so. Achieving action analytics is more about leading and navigating significant changes in organizational culture and behavior than technology."[33]	• Institution
	"[A] fusion of new analytic tools with the increasing expectations for higher education accountability."[34]	• Institution

Source: Van Barneveld, Arnold, and Campbell, "Analytics in Higher Education," January 2012.



Source: Van Barneveld, Arnold, and Campbell, *Analytics in Higher Education*, January 2012.

Figure A.1. Analytics

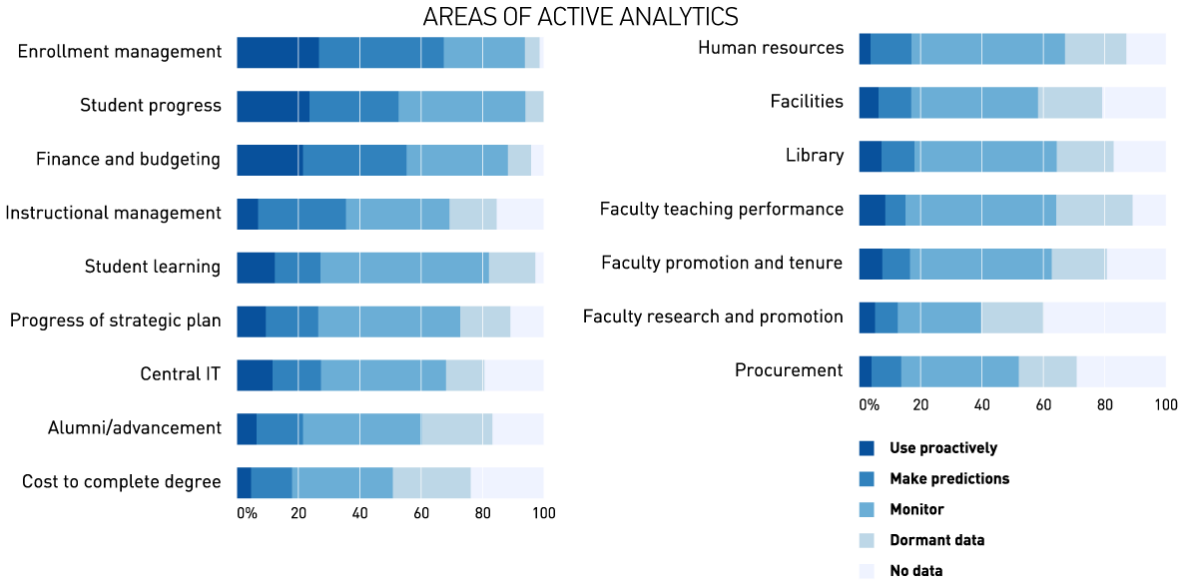


Figure A.2. ECAR findings: most activity in student and finance, least in faculty

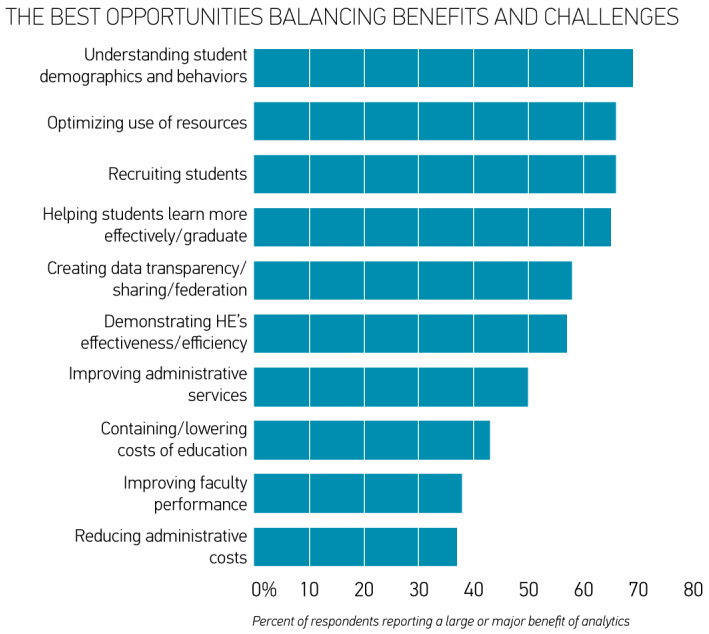


Figure A.3. ECAR findings: More optimism around student areas than cost or faculty

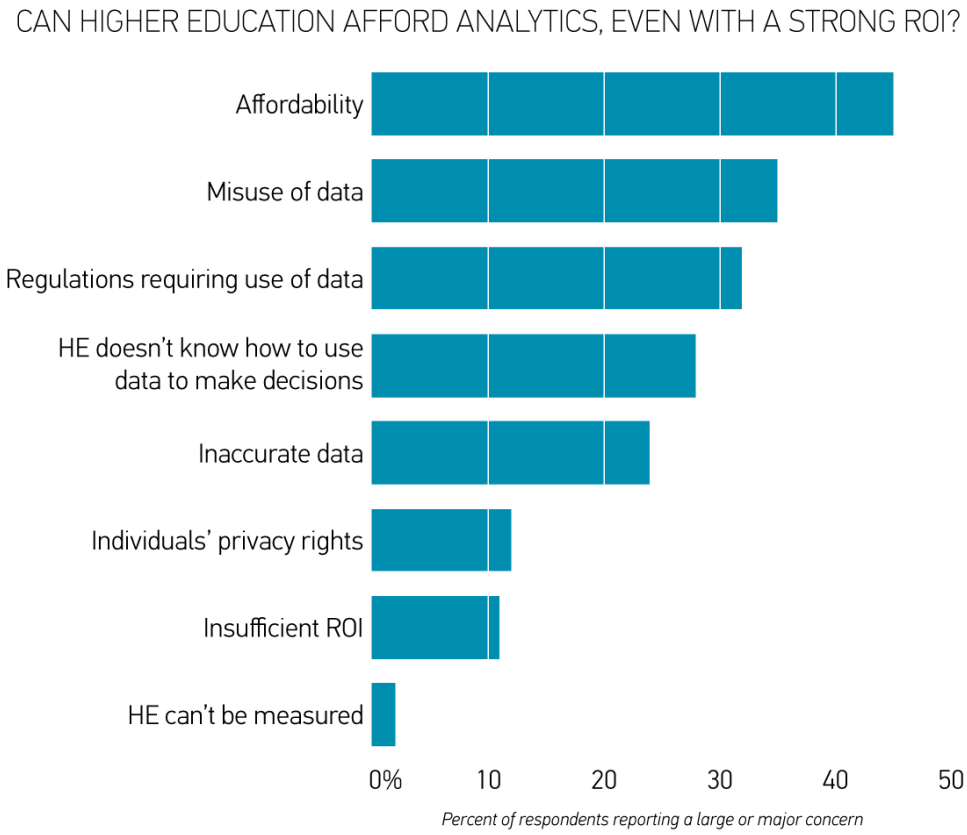


Figure A.4. ECAR findings: Data and affordability are the biggest concerns

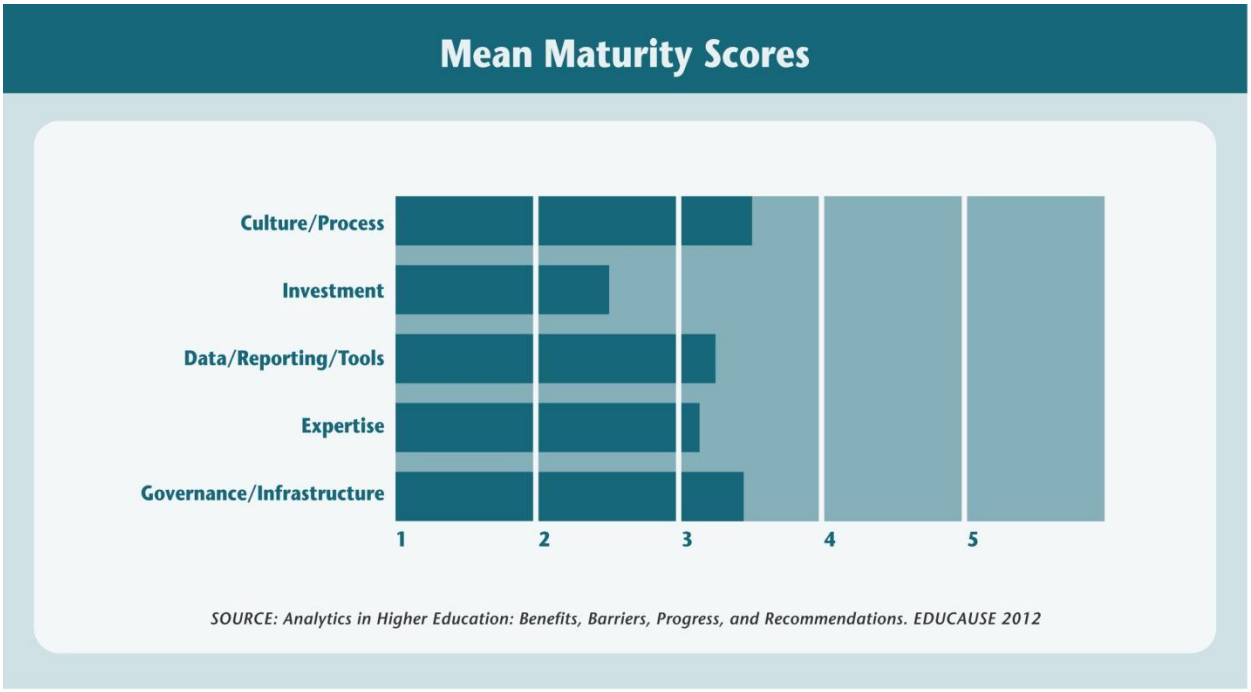


Figure A.5. ECAR analytics maturity index

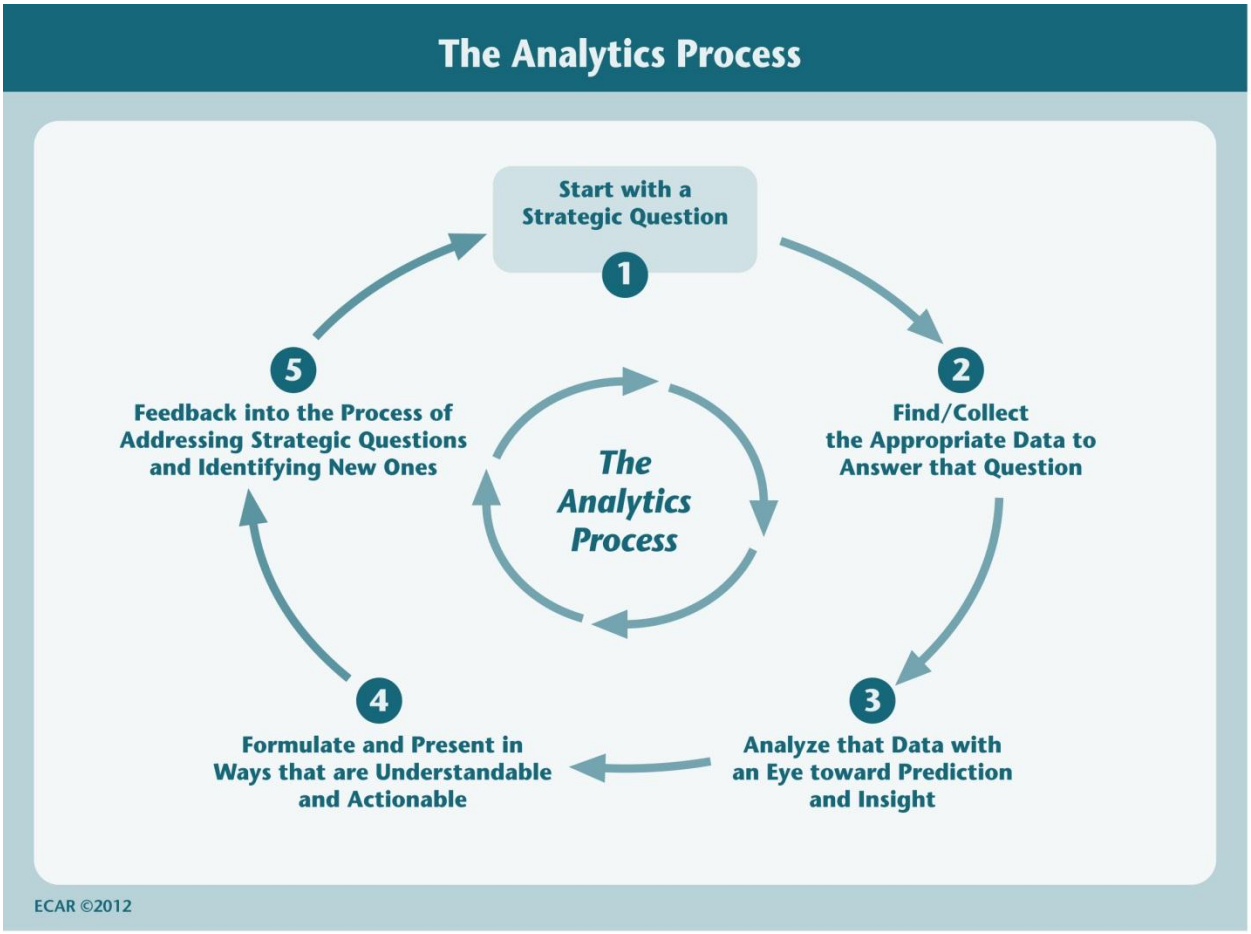


Figure A.6. The analytics process

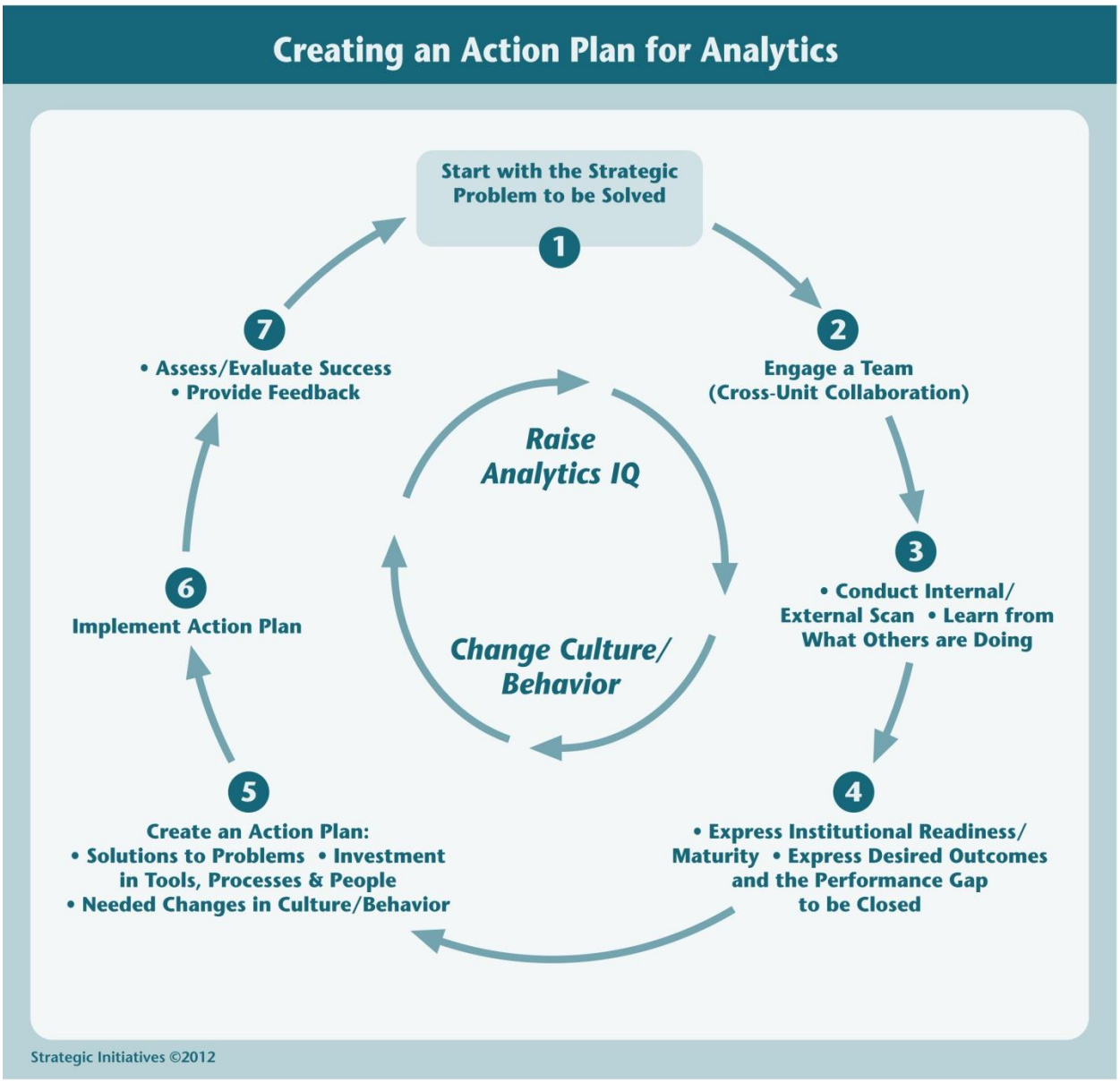


Figure A.7. Materials from the toolkit

Figure A.8. Additional materials from the toolkit

Figure A.9. The eight accelerators

Appendix B: FAQs and Match-Up Services

Answers to Frequently Asked Questions

The answers to FAQs should provide practical, easy-to-follow guidance on how to proceed and a linkage to electronic resources that can help. This is a short, sample list of FAQs. In practice the list would grow through use and be extended to cover many different questions and circumstances.

1. **How can I convince my institution's leadership that analytics is a good investment?**
    a. **Instructions on building a case for ROI from student success analytics and achieving high-level commitment**
    b. **Refer to ROI from other institutions**
    c. **Move beyond ROI (necessary but not sufficient) to answers sustaining institutional values**
    d. **Refer to resources on "How to Raise Analytics IQ and Build Executive Commitment"**
2. **How do I get started in student success analytics?**
    a. **Written answer based on synthesis of best practices from case studies**
    b. **Written answer based on synthesis of industry research—refer to simplified version of IBM/MIT Sloan five steps to getting started and Davenport Steps on getting started**
    c. **Drill down to five steps and provide guidance in each (repurposing materials from toolkit)**
3. **How can I build on and extend my current student success analytics efforts?**
    a. **Written answer—how to assess where you are and readiness to advance**
    b. **Linkage to examples of similar institutions**
4. **How can I determine my institution's readiness for analytics?**
    a. **Written answer**
    b. **Reference to Readiness for Analytics templates with samples filled in for various institutions**
5. **How can I collaborate with other institutions to advance analytics for student success?**
    a. **Written answer—describe various dimensions of collaborations**
    b. **Linkage to parts of case studies describing collaborations**
    c. **Linkage to listing collaborative groups working together, including professional society–facilitated collaborations and partnerships**
6. **How can I access analytics talent without having to hire them? What kinds of analytics talent are needed to develop and operate student success analytics tools using predictive modeling?**
    a. **Written answer—description of various mechanisms**
    b. **Linkages to job descriptions and resources available through collaboration, vendors, or other means**
7. **What are the different approaches for an institution to focus on learners and track their success?**
    a. **Meta-analysis of leading institutions' approaches to learner relationship management**
    b. **Linkages to vendors who claim LRM capability**
8. **Who would be a good partner to assist in developing organizational capacity?**

Match-Up Services

The match-up services are a highly granular capacity to use analytical functionality to find out what vendors are offering which analytics technologies, tools, applications, solutions, and services.

Users would be able to query about the details of vendor tools, applications, and solutions, using dropdown menus and directions. They could also find out which institutions are using those solutions and what referenceable accounts are involved.

1. **What are other institutions like mine doing for analytics to support student success?**
    a. **Written answer describing search options**
    b. **List and drill down to the full case studies of similar institutions from among the 40+ institutional case studies (which will grow over time—both case study narrative and raw information)**
    c. **Cross-listing to other resources, such as cases from AASCU, AACC, or AACRAO and webinars**
2. **What are institutions doing in the different analytics categories (framework for optimizing student success), and what vendor solutions are they deploying to do so?**
    a. **Drill down to view institutional responses**
    b. **Optimize student success categories**
        i. **Managing the student pipeline**
        ii. **Eliminating structural, policy, and programmatic impediments to retention and success**
        iii. **Using dynamic query, reporting, and intervention to respond to at-risk behavior**
        iv. **Evolving active learner relationship management systems and practices**
        v. **Enabling personalized learning environments/practices and enhanced learning analytics**
        vi. **Engaging in large-scale data mining**
        vii. **Extending student success to include employability**
    c. **Identify vendor solutions associated with these categories**
3. **What specific vendor solutions are available for BI/analytics?**
    a. **Dropdown menu or other means to identify and select vendor solutions and characteristics of these solutions**
    b. **Tentative analytics solution options—with full listing of characteristics associated with them**
        i. **Summary of analytics products, applications, solutions**
        ii. **BI/analytics tools/products—full dropdown menu of items**
        iii. **Data sets from which the tools draw**
        iv. **Licensing options**
        v. **Installation options**
        vi. **Hardware platforms**
        vii. **Institutions as referenced accounts/case studies**
        viii. **Future vision**
4. **What solutions are vendors offering specifically tailored to student retention and success? (Include institutions that are making their software available.)**
    a. **Dropdown menu**