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White Paper

WHAT EVERY LEADER NEEDS TO KNOW ABOUT STUDENT SUCCESS ANALYTICS

Authored by

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What Every Leader Needs to Know About Student Success Analytics

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This white paper provides campus leaders with insights on current and emerging best practices in student success analytics in higher education. It also presents implications for the future. These new practices promise to dramatically improve our capacity to improve student success across the entire spectrum of the student lifecycle and in all aspects of the student experience. They will enable institutions to move beyond institutional accountability statistics to improve performance at the level of student success processes, practices, and interventions. This is where the action is. Ultimately, these new processes, practices, and interventions promise to be the toolkit for reinventing and personalizing approaches to success, reaching levels never before attainable.

By leveraging analytics and data science, leading-edge institutions are raising their aspirations to truly "optimize" student success for individuals and cohorts. Such institutions are making the optimization of student success a mission-critical, overarching institutional strategy. "Student success science" is emerging as a key ingredient in reimagining higher education. This white paper shows institutional leaders how to raise their analytics IQ so that they can leverage these practices to better serve their students, improve performance, and demonstrate value.

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I. Raising the Bar on Analytics and Student Success

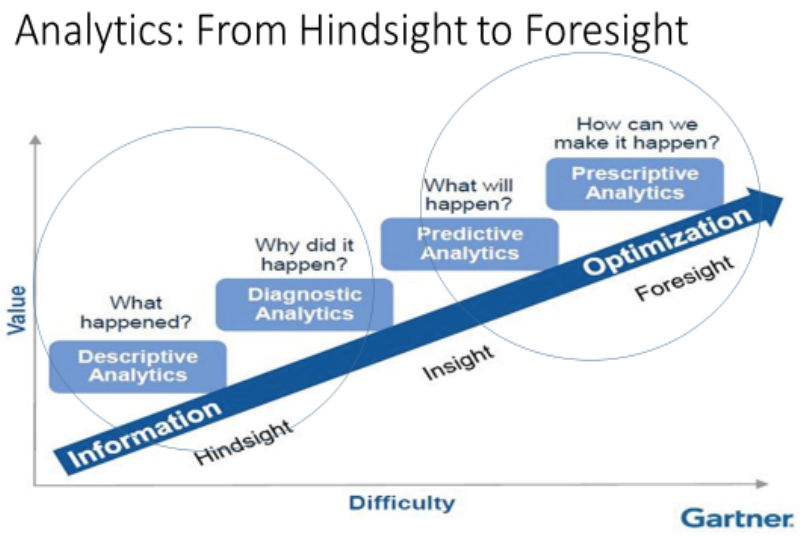
Universities and colleges have access to more data than at any time in their history. They also face more pressure than ever before to make the best data-informed decisions. By utilizing advanced analytics, machine learning, and data science modeling, campuses now have the opportunity to move from static and stale data to real-time dashboards and predictive models that increase the number, frequency, and effectiveness of interventions.

As recently as a few years ago, many institutional leaders were satisfied with the 20/20 hindsight provided by descriptive, longitudinal data, standard reports, and accountability statistics on what was happening in retention and graduation rates. Today, leaders are boldly advancing the use of analytics to improve student success. They are using analytics to generate insight on why things are happening, foresight on what will happen if trends continue and/or behavior is not changed, and prescriptive interventions that aim to change and/or mitigate risky behavior. Figure 1 from the Gartner Group [1] captures the continuing evolution of four distinct kinds of analytics that are described below:

- Descriptive Analytics – What has happened?
- Diagnostic Analytics – Why did it happen?
- Predictive Analytics – What will happen if past trends and current behaviors continue?
- Prescriptive Analytics – What is the best that can happen and how can we make it so?

Descriptive Analytics is the foundation for providing information on performance. In terms of student success, campuses regularly report volumes of information regarding enrollment, persistence, and graduation. Reports are fundamentally historical in nature, describing the results of behavior that has happened in the past. For example, assessing the persistence rates of students entering a college or university from a particular high school captures performance that has already occurred. Another example of useful descriptive analytics is the number and distribution of DFW grades in particular courses, especially so-called gateway courses. Campuses may assess the level and distribution of DFWs and investigate how to improve student success in critical first-year courses to improve persistence and completion. In most institutions, descriptive analytics commands the majority of time and effort by institutional research and planning staff. It can be the gateway to more advanced analytics, or it can drain the time and energies of analytical staff that could be addressing more advanced levels of analytics.

Figure 1:



Diagnostic Analytics assess why a particular result is occurring. This level of analytics looks at the context of the data and evaluates what factors may be contributing to the outcomes in evidence. An example would be assessing the patterns of course-taking behavior of high school students prior to entering the college or university to determine readiness. In the DFW (D, F, Withdraw) grade example, such diagnostic analysis could lead the academic leadership and faculty to assess how well first-year courses are meeting students' needs. This level of diagnostic reporting requires more analytical skills and access to a variety of data sources, including cross-institutional data, than simple descriptive analysis.

Predictive Analytics moves to a heightened plane of insight regarding performance. It analyzes what will happen next if trends continue or past behavior is not changed. Predictive analysis can assess whether current activities or behaviors will yield predicted outcomes if interventions are not launched. For example, assessing the level of math that students completed in high school would include taking assessment tests in 10th and 11th grade to record level of math readiness for college and then acting on the results by expanding advising to increase math taking and success prior to entering college. This requires predictive analysis in determining what actions are shown to support increasing math readiness and then taking action early enough to make a difference. Further, assessing the "what will happen next" in DFW grades looks at whether more frequent assessment of student performance can monitor at-risk behavior before a student withdraws or fails the course. Such analysis can also work to support course redesign, inform improved course sequencing, and address inconsistencies in grading.

Prescriptive Analytics moves the needle forward to address how campuses can improve performance through leveraging predictive analytics to launch interventions that optimize performance. This level of analysis requires the ability to view and assess the efficacy of different interventions and student support efforts. When it comes to student success, "One size does not fit all," so this level requires deeper research and assessment of what interventions work for which students at what time in the student educational life cycle. Examples of prescriptive analytics include requiring certain math courses in high school prior to admission to college, expanding dual enrollment options and AP, developing variations on course design of math for success, use of tutoring or skill development such as the Khan Academy. In the DFW example, early warning and at-risk monitoring results in active and "intrusive" advising that will assess student behavior and provide support for the student early enough to make a difference. This level of analysis can

assess what the issue may be for students whether it is preparation, time management, or lack of engagement, then act on their behavior with the right intervention.

Making the leap from descriptive/diagnostic analytics to predictive/prescriptive analytic and interventions enables institutional leaders to take a new perspective. They can envision the ecosystem of student success from a more comprehensive approach, taking a long term and sustainable decision to improve performance. In fact, as the data and predictive modeling come together with the institutional try and test methodology, campuses can achieve exponential growth in student success. They can aspire to optimize student success for individuals and cohorts. They find that student success analytics affects decision making in substantial ways:

- Shapes decisions, interventions, and allocations of resources;
- Enables institutions to reduce and/or mitigate risk in a wide range of ways;
- Supports interventions in the student pipeline, processes, support services, structures, practices, at-risk behaviors/choices of individual students; and
- Enables personalization of student success interventions and solutions.

The value and impact on decision-making will increase as the level of analytical capabilities grows to include more predictive and prescriptive analytics. As high schools work more closely with colleges and universities to determine readiness and increase access to dual enrollment opportunities course content may take on additional focus. As faculty, advisors, and students assess student engagement and behavior early and often, at-risk behavior can be identified and acted on in a timely manner. This can result in a more personalized approach to student persistence and success.

II. Examples of Student Success Analytics from Leading Institutions

Analytics is potentially a key ingredient in sense-making and decision-making in all aspects of institutional performance. But it is especially critical in improving student success. Enlightened institutional leaders across higher education are committing to analytics and data science that drive active interventions intended to improve student success. Increasingly these interventions are personalized and driven by insights discovered through analytics.

> "It's not about the analytics, alone; it's about the commitment to persistent, personalized actions and interventions to improve student success guided by analytics-based insights."
>
> Linda Baer and Donald Norris

The uses of analytics in higher education and the interventions they drive have been advancing perceptibly among leading institutions, with tangible results. Our research on leading analytics institutions[2] determined that many were deploying analytics along seven distinctive dimensions that spanned the student life-cycle, and all parts of the student experience (curricular, co-curricular and work). The dimensions at the top of this typology are the most highly developed and mature. Those at the bottom are less well developed and emergent. They are also sources of substantial opportunity for future improvement. Taken together, leveraging the actions and interventions along these dimensions has the potential to substantially reduce and/or mitigate risk and increase student success, as demonstrated in Table 1.

Managing the Pipeline

Institutions have been utilizing descriptive/diagnostic analytics for years to shape their entering classes, refine policies, and identify at-risk students for mentoring and special interventions. Institutions are using such strategic enrollment management techniques to improve their yield/conversion rates, enhance current enrollments, and improve retention. In recent years, predictive analytics have been added to these practices. The University of Texas at Austin[3] is recognized as a best-practice leader for its use of predictive analytics to identify at-risk students and to craft mentoring and support experiences for them. Georgia State University[4] is often cited as a leader in overall analytics-driven retention improvement practices that continue throughout the student life-cycle.

Eliminating Barriers, Obstacles and Risky Structures/Practices/Processes

Institutions have utilized descriptive and diagnostic analytics to create best practices that reduce risk in structures, processes, and policies. Favorite best practices have included reinventing the first-year experience; eliminating barriers, bottlenecks, and inconsistencies of approach; providing better mentoring and advising; and advancing peer-to-peer learning and tutoring (supplemental instruction). In addition, creating a focus on guided course and service pathways for students improves decision making over the traditional cafeteria-based choices that often overwhelm students. See Redesigning America's Community Colleges.[5] A number of organizations have been actively promoting such best practices, where they being tailored to the institutional context.

Complete College America[6] is currently receiving significant praise for its interconnected set of best practices which are producing substantial gains in student success. These include: 1) performance funding, 2) co-requisite remediation, 3) full time = 15 credits, 4) structured schedules and 5) guided pathways. These best practices are being tailored to many institutional settings and even statewide deployment among public institutions. It needs to be noted that Complete College America is targeting improvements for first-time, full-time students, thus the emphasis on full time = 15 credits. Students who can maintain 15 credits per term do, in fact, finish in a timelier manner. The majority of students do not fit into this category, however; and to date, appropriate metrics for part-time students have not emerged.

Dynamic Interventions in Real Time

For some time, for-profit institutions like the American Public University System (APUS), Capella University, and the University of Phoenix have utilized embedded practice techniques – the Education Trust, Achieving the Dream, the Bill & Melinda Gates Foundation – and these best practices are being deployed in many institutions predictive analytics to identify at-risk behavior by online students. Purdue University utilized its Course Signals product with embedded predictive modeling to give students a red, yellow, or green light warnings of their progress, starting with students in large freshman courses. Rio Salado College developed similar alert/intervention capabilities.

Software providers like iStrategy and Blackboard Analytics have used pre-packaged analytics applications to enable institutions to provide dynamic, real-time assessment, alert and intervention capabilities to front-line faculty and staff. An important contribution of such user-friendly applications is that they enable "analytics for the masses," liberating the energies of analytics staff to undertake higher-level predictive and prescriptive analytics. Such applications have been the foundation for the leadership of institutions like the University of Maryland Baltimore County[7] to become recognized leaders in building cultures of evidence and student success improvement.

Civitas Learning is blending advanced data science into such intervention delivery systems. The Student Success Solutions from Civitas Learning include Inspire for Faculty and Inspire for Advisors where full data mapping of the students in a current course and the full advising load is depicted in an actionable "heat map"

that reflects who is doing well, who needs some assistance, and who is in trouble, and provides suggested interventions to address those risks.

Integrated Planning, Advising/Alert Systems (IPAS)

Over the past decade, many leading institutions have developed sophisticated student advising and pathway planning systems. Systems at Sinclair Community College, Valencia Community College, Arizona State University, Austin Peay State University, and Georgia State University, among many others, have demonstrated that impressive improvements are possible when students are advised into guided, planned pathways and provided with a combination of education planning, counseling and coaching, risk targeting and intervention, and transfer and articulation guidance.

Arizona State University's eAdvisor is a case in point. Before eAdvisor, 33% of first-year students were in "exploratory" majors; the figure now is now 8%. Students also use eAdvisor to map their degree plan and track progress toward completion. Implementing eAdvisor has generated $7.3M in advising cost savings per year and $6.5M in instructional cost savings per year. Student success has also improved since deploying eAdvisor. The 4-year graduation rate improved by more than 9% relative to before eAdvisor was deployed[8].

These advising systems have expanded to include dynamic, analytics-driven interventions and additional functions. The Bill & Melinda Gates Foundation has supported the development and definition of these so-called Integrated Planning Advising/Alert Systems (IPAS) which have emerged as "an institutional capability to create shared ownership for educational progress by providing students, faculty, and staff with holistic information and services that contribute to the completion of a degree or other credential[9]."

For example, Civitas Learning's Degree Map application provides advisors and students with the capabilities of seeing student progress in a major, what courses remain, or what happens when a student considers a change of major, including time and cost. The Degree Map implementation at Austin Community College has shown that "when students have more clarity and control of their degree path, they're significantly more likely to make progress on their learning path and, best of all, cross the finish line and complete a certificate or degree. These are the kinds of outcomes all of our student success innovations are shooting for!"(Richard Rhodes President and CEO, Austin Community College).

The EDUCAUSE Center for Applied Research (ECAR) has benchmarked the characteristics of these emerging IPAS systems/services[10]. They offer a range of services that seek to realize a comprehensive vision of a technology-enabled and integrated digital environment that provide students, advisors, and faculty with the following capabilities:

- Education planning (identifying the degree and the best path to its achievement)
- Progress tracking (asking whether the learner is on course toward degree completion)
- Advising and counseling (offering services such as mentoring and tutoring)
- Early-alert systems (initiating proactive intervention with at-risk students)

Over time, IPAS systems promise to expand their functionality and become the primary multifaceted vehicle for institutions managing the overall context of student success. For example, through the Civitas Learning predictive models, campuses can identify which interventions are working, for whom, and by what mode they should be delivered. In addition, the solution tools provide insight into which inspirations can be provided to take a student to the next level.

Next Generation Personalized and Competence-Based Learning

Personalized, adaptive learning and competence-based learning promise to usher in a new era of pervasive learning analytics, which is defined by Brown, Dehoney, and Millichamp as "the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding an optimizing learning and the environments in which it occurs[11]." These embedded learning analytics will automatically and continuously collect data on learner progress and attainment, and require far more robust analytics and management tools. The Bill & Melinda Gates Foundation and other groups have been actively supporting the development of Next Gen Learning through pilot projects at a range of institutions and support of a range of cloud-based vendor offerings to help build the industry.

Moreover, the coming emergence of in-the-cloud Next Generation Digital Learning Environments (NGDLE) will enable the seamless combination of learning and developmental experiences from a wide range of sources: institution-centric courses, prior learning, free-range learning experiences, and other co-curricular and work activities. NGDLE will need to incorporate three types of learning data: dispositional (e.g. incoming GPA, biographic and demographic data), course activity and engagement (e.g. keystrokes, selections, time on task), and learner artifacts (e.g. essays, blog posts, media products)[11]. Taken together, these developments will expand the diversity of learning and developmental experiences to be measured, the dimensions of student success, and how they all can be measured. Over the next few years, institutional leaders should carefully track the development of NGDLE and the new solutions available.

Big Data and Data Science

For a number of years, a relatively small number of institutions have been engaging in data mining and Big Data applications to illuminate issues relating to retention and student success. Most of these institutions utilized faculty with data mining expertise to develop homegrown solutions. The introduction of data science experts enables institutions to profoundly understand student success for individuals and clusters of students to a degree never before possible. Such institutions have been able to move beyond implementing generalized best practices toward creating personalized learning experiences and interventions that optimize learning for individual students.

Data science can create predictive models that lead to prescriptive interventions. Civitas Learning is pioneering the deployment of such data science-based techniques. The results are being embedded in many of the dimensions of the student success typology. Over the next few years, these applications will support dramatic growth in "student success science," which is bringing together data science and student success to improve information, knowledge, and action around improving student persistence and completion.

Expanding Success to Include Employability and Career

Many institutions are expanding the definition success to include employability and career success. The Lone Star College System[12] introduced an integrated Education and Career Positioning System (ECPS) that lets students, faculty, advisors, and parents simulate, navigate, validate, and plan a student's education-to-career options to select the best individual journey for that student. The ECPS takes all personalized interests, values, skills, and academic records for students and distributes personalized student analytics directly to them for planning. Colorado State University's[13] comprehensive, holistic approach to student success considers all element of the student experience (curricular, co-curricular, and work). Over time, it is clear that IPAS systems will be expanded to manage and take account of the full range of learner developmental experiences, including entrepreneurship and innovation activities, design competitions, co-op experiences, and a myriad of others.

The leading analytics institutions that we studied were leveraging analytics in five to seven of these categories, but even these leaders are far from tapping the full potential of optimizing student success. Table 1 summarizes how actions and interventions along these seven dimensions are being utilized to reduce, manage, and/or mitigate risk by leading institutions.

Table 1: Analytics-Based Interventions to Manage/Mitigate Risk and Optimize Student Success

Dimensions	Interventions	Risks Mitigated and/or Managed
1. Manage the Student Pipeline	• Manage the student pipeline, select students carefully, refine policies/practices • Accelerate enrollment of eligible students • Provide targeted mentoring and support for at-risk students	• Inefficient yields/conversion of enrollments at all stages • At-risk students in the admissions pipeline and after enrollment, through to completion
2. Eliminate Bottlenecks and Barriers	• Reinvent first-year experience • Eliminate course bottlenecks • Improve performance in weed-out courses • Improve consistency in grading and faculty practices • Implement best practices such as Complete College America's suggested list: 1) performance funding, 2) co-requisite remediation, 3) full time = 15, 4) structured schedules, and 5) guided pathways. • Develop guided pathways as opposed to the cafeteria model of course choice for students	• Risky structures, policies, and practices in core offerings • Inconsistent grading and faculty practices that impede student success • Risky approaches to remediation, degree planning and execution of plan • Provides clearer choices for students which can keep students on a focused course of academic action
3. Dynamic Interventions to Address Risky Behavior	• Dynamic, real-time interventions by faculty, advisors, and mentors • Automatic assessment of risks and generation of alerts enables continuous monitoring and intervention	• Risky behavior (identified based on predictive analytics), in real-time • Multiple factors are included in determination of risk, and these assessments can personalize interventions
4. Leverage Individual Planning and	• Individual pathway planning • Intervene when learners deviate from success paths illuminated through	• Steer learners toward proven success paths, quickly • Reduce risky choices

Advising/Alert Systems (IPAS)	predictive analytics • Monitor progress/risky behavior and intervene in full spectrum of curricular and co-curricular areas • Combine best practice and data science-driven interventions	• Reduce deviation from pathways • Add career and employment considerations early in student career

Table 1: Analytics-Based Interventions to Manage/Mitigate Risk and Optimize Student Success (Continued)

Dimensions	Interventions	Risks Mitigated and/or Managed
5. Next Gen Learning	• Embedded analytics enable autonomic, real-time intervention in the individual courses/learning experiences • Increases dramatically the number, focus and effectiveness of interventions, accelerates student learning	• Enable personalization of learning style and outcomes, building commitment • Focus on tangible outcomes • Utilize embedded analytics in courses to mitigate risky learning behavior • Consider the entire "connected learning" record for each learner
6. Big Data/Data Science	• Student Success Science provides profound insights in all aspects of the interventions that optimize student success support at the individual, cluster, and cohort levels • Dynamic, real-time interventions based on predictive analytics • Cross-institutional data mining generates insights for interventions	• Reduces the risk of "best practice"-based interventions that are not tailored to the individual • Big Data and Data Science-based interventions are used throughout the student life cycle
7. Academic and Employability Success	• Mentoring and advising provide success-making interventions, guided by pathways to success research	• Reduce risk of mismatch between learning and employability • Reduce risk of learner lack of engagement and disillusionment

III. Most Institutions Lag behind the Rising Standards of Analytics Best Practices

As already discussed, impressive gains are being registered by leading analytics institutions. However many, if not most, institutions are having difficulty in gaining momentum with analytics and are confused in the distinction between reporting and analytics[14]. Many institutions are awash in data, yet the data are hiding in plain sight trapped in data siloes, inadequately served by data-warehouse based aggregations, and poorly integrated. Moreover, dirty data abound in many settings and data quality is a concern for institutions trying to gain momentum with analytics. Serious data stewardship requires commitment that has been lacking in many institutions. When data are not being scrutinized and scrubbed through regular use in support of important decision-making, data quality suffers.

Taking Steps to Gain Momentum with Analytics

Many institutional leaders are coming to grips with the need to gain momentum in student success analytics. They are realizing they need more than the hindsight provided by descriptive and diagnostic analytics. They need the insight and foresight provided by predictive/prescriptive analytics in order to improve decision-making and outcomes. Most institutional leaders are pursuing analytics pilots, seeking assistance from analytics and student success solution providers, and/or mashing up a few analytics applications. Many are resorting to adapting proven student success best practices from other institutions that do not require their institution to develop its own predictive analytics capabilities. The Higher Learning Commission has launched a Persistence and Completion Academy to guide and coach campuses through the data to analysis stages of development in order to improve overall student success[15]

The Widening Gap between Analytics Best Practice and Average Practice

Meanwhile, leading-edge practices are moving forward faster than the progress of most institutional analytics capabilities. We have the sense that the gap between analytics best practice and average institutional practice may be widening. Leading-edge analytics institutions are finding ways to make serious investments in the organizational capacities needed to deploy student success analytics. In the process, they are discovering that institutional capacity for student success analytics is about much more than simply technology infrastructure, business intelligence tools, and analytics applications.

> For most colleges and universities, the gap between their current analytics capacity and best practices by leading institutions seems to be widening, not closing.
>
> Linda Baer and Donald Norris

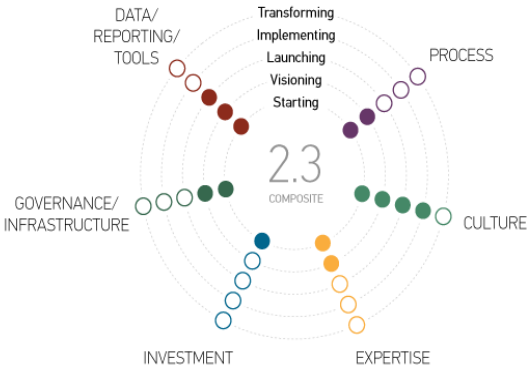
Building Organizational Capacity for Student Success Analytics Is a Long-Term Campaign

Even when achieving rapid gains through partnering with solution providers, building organizational capacity for analytics is a long-term campaign. In ***A Toolkit for Building Organizational Capacity for Analytics***, Norris and Baer described the many facets of purposefully developing organizational capacity for analytics, and the critical importance of leadership and changing the culture to achieve analytics excellence[16]. Many of the leading analytics institutions surveyed by Norris and Baer had taken seven to ten years to build a substantial analytics capacity, which required continuous refinement and extension to reflect the raising of the bar for student success analytics. Through a survey of IT and IR professionals in higher education, ECAR created an Analytics Maturity Index[17, 18] which consists of six interconnected dimensions of analytics capacity, along which institutions could measure their levels of development and readiness:

- Data Reporting/Tools
- Governance/Infrastructure
- Investment
- Expertise
- Processes
- Culture

The critical context here is the view of the overall ecosystem of the campus and the dedication to systematically working on building organizational capacity. This means consistent communication and integration between academic and student affairs, student success initiatives, as well as a deep collaboration with the infrastructure support teams. In addition, the Analytics Maturity Index allows a campus to determine level of progress from starting, visioning, launching, implementing, and transforming, as illustrated in Figure 2:

Figure 2. ECAR Analytics Maturity Index



IV. Getting Help in Advancing Student Success

A key element of organizational capacity is skilled talent. Institutions of higher education have reasonably well developed talent in descriptive and diagnostic analytics, but it is unevenly distributed across institutional types. Many community colleges and small institutions have a single institutional researcher or none at all. As for predictive and prescriptive analytics, most institutions lack access to professionals who have the necessary talent and training to deploy student success science. But higher education is not alone. The analytics talent gap exists in all industries, as data science becomes a critical element of success. Coming late to the game, higher education is especially challenged in attracting such professionals and paying the salaries they command.

Our experience shows that institutions need help in advancing student success analytics. First, they need to assemble working groups and teams that functionally work together to optimize institutional strategy (working together instead of against each other). Most institutions have many fragmented efforts contributing to student success and "connecting the dots" among them enables institutions to leverage their efforts. Second, institutions need to forge strong relationships with technology vendors and solution providers that will develop the technology infrastructure, processes, skills, and practices needed for student success analytics. Third, institutions need to utilize partnerships, collaborations, consortia/federations, and

shared services to share talent, best practices, and insights. Taken together, these efforts will accelerate institutional progress and cut years off an institutions timeline for making significant analytics progress.

The roster of vendors and solution providers supporting student success analytics continues to grow in number and their service offerings are evolving rapidly. Consider the following categories of student success support and examples in each (a list meant to be provocative, not exhaustive):

- **Integrated Planning and Advising Systems.** This broad category includes four types of providers:

  - ✓ ***Legacy ERP/SIS/LMS Systems*** that have adapted their enterprise systems to support four key elements of IPAS functionality: 1) education planning, 2) counseling and coaching, 3) risk-targeting and intervention, and 4) transfer and articulation. Vendors include Ellucian, Peoplsoft/ORACLE, Canvas, Jenzabar, Blackboard, D2L, and Moodle.

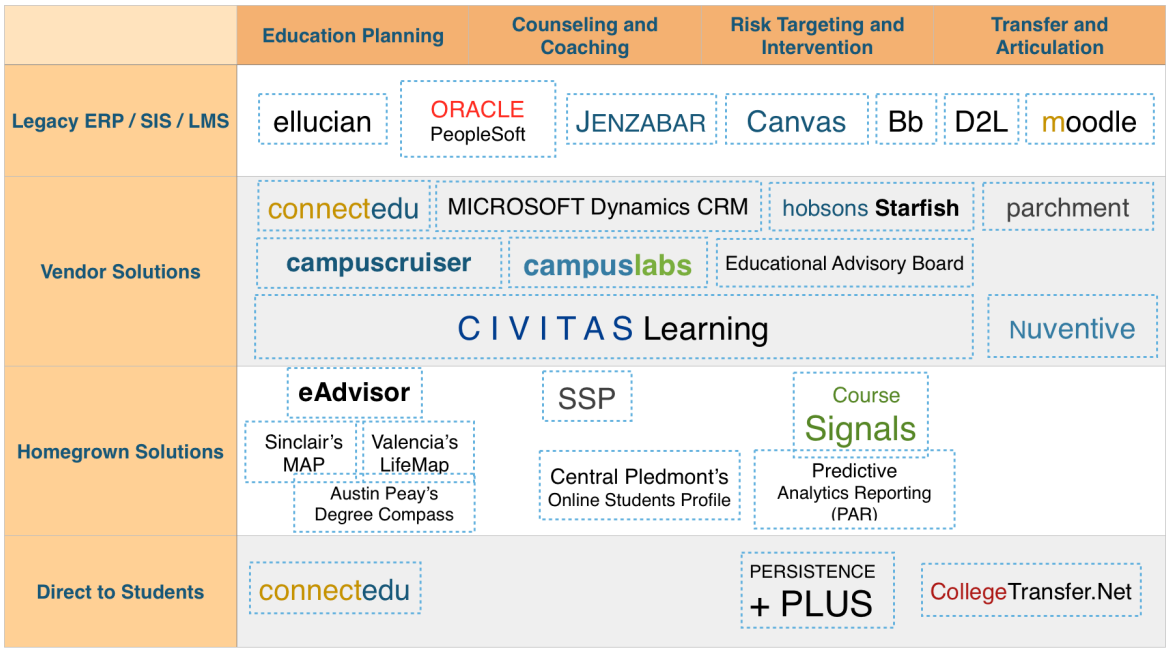
  - ✓ ***Vendor Solutions*** that provide a portion of IPAS's four functionalities key players in this segment are campuscruiser, Hobsons/Starfish, Civitas Learning, Campuslabs, Nuventive, and Education Advisory Board.

  - ✓ ***Homegrown Solutions in the Advising Area*** are represented by examples like Sinclair Community College's MAP, Valencia College's LifeMap, Arizona State University's eAdvisor, Austin Peay University's Degree Compass, Central Piedmont Community College's Online Students Profile, and the Predictive Analytics Reporting (PAR).

  - ✓ ***Direct to Student Services*** such as ConnectEdu (Education Planning), Persistence +Plus (risk targeting and intervention), and CollegeTransfer.Net (Transfer and articulation).

The following Table 2 summarizes the elements of the emerging IPAS marketplace. Over time, most of the enterprise and point solution vendors will be considered IPAS solution providers, all contributing to the overall enterprise solution capability to optimize student success, utilizing insight into the entire student/learner experience – curricular, co-curricular, and work.

Table 2: The Emerging IPAS Solution Provider Marketplace



- **Next Generation Learning.** As institutions are gearing up for personalized learning and competence-based learning, they are turning to a new constellation of vendor and solution provider partners: The Next Gen Learning solution providers have a very different focus than the IPAS providers; they are preparing institutions and the higher education industry for personalized/competence-based learning, connected interoperability, and embedded analytics. The main change-management/cultural focus is on faculty development and acceptance of new practices.

  - ✓ **Smart Courseware -** A variety of players are working to advance personalized and competence learning: SmartSparrow, Acrobatiq, Lumen Learning, Cogbooks, Cerego, and others. Also, MOOC providers like Coursera and edX are looking to utilize MOOCS to deliver personalized learning, at scale, to higher education.

  - ✓ **Cloud-based Solutions to Make LMS Smarter -** A variety of providers like Ace Learning provide cloud-based services to leverage the packaging of learning objects into courseware, embed analytics in personalized learning and scale up institutional efforts in these areas.

  - ✓ **Next Generation Digital Learning Environment (NGDLE) -** The so-called NGDLE will follow the Caliper interoperability standards espoused by IMS Global and will enable institutions to mash up all the different modes of "connected learning" that will define the learning environment of the future. Emerging NGDLE providers like Unizin, which has been formed as a consortium of R1 institutions, are attracting attention to the loose coupling of LMS, Content, and Analytics that will characterize NGDLE.

Importantly, NGDLE have the strategic intent of reducing the cost of administrative support functions so that resources can be reallocated to academic technology-based activities.

- **Decision Support Science -** Many of the analytics providers are including predictive modeling in their offerings, either as an embedded element or as a bolt-on function. More rigorous data science capabilities are also on offer. Civitas Learning's Illume application provides a full-blown data science application to institutions, where in using their own data well, they can explore various combinations of correlative factors and identify the elements at their institution that are impacting student success. Then, they can develop monitoring, alert, and intervention mechanisms personalized to individual learners. Predictive Analytics Reporting (PAR) has assembled a federation of 33 institutions, the combined coverage of which is well over 2 million student records. PAR utilizes advanced analytics to identify best practices for student success in that federation and shares the best practices with its members.

- **Employability, Career Planning, and Capturing Co-Curricular/Work Experiences -** Examples like Lone Star College's Education and Career Positioning System (ECPS) illustrate the green shoots in the area of extending academic planning to include employability and career planning. Most of these efforts will likely be expressed through expanding robust IPAS capabilities to incorporate the full range of curricular, co-curricular, and work experiences in student planning and transcripting of learning and demonstrated competences/experiences.

The Age of Analytics will usher in a new age of talent sharing, involving skills, processes, and practices. This sharing will also include insights in the new organizational culture focusing on optimizing student success.

V. Changing the Culture

Leading analytics institutions are in the process of evolving their cultures from one of reporting to one of evidence to a culture of student success improvement.

Culture of Reporting → Culture of Evidence → Culture of Student Success Improvement

- **Culture of Reporting -** Many institutions are still stuck in a culture of reporting, where standard reports and descriptive analyses accompany decision making. Fragmented data, lack of user-friendly information, and too few people responsible for too many reports results in being bogged down in the lowest levels of data insights.

- **Culture of Evidence -** Most institutions are in the process of shifting to a culture of evidence, where decision makers increasingly demand that their decisions be guided by analytical evidence. Yet they struggle with getting the right information and analysis at the right time and place. Institutions at this stage are also pushing decision making down into the organization and creating an imperative to act in the face of evidence. Decision-making requires not just the responsibility but also the authority and resources to implement changes necessary to improve.

- **Culture of Student Success Improvement** - Leading institutions are embracing the notion of a culture of student success improvement, which requires not just a dedication to acting in the face of evidence, but a commitment to personalizing interventions and reinventing our core processes to do so. Student success optimization is a goal, requiring a mash-up of best practices, personalized planning and interventions, and constant trying and testing.

Leadership and cultural change are the two most critical elements for institutions wishing to optimize student success.

Committing to a Culture of Student Success Improvement

These commitments to cultural change are at the heart of the optimizing student success revolution. For example, Civitas Learning has committed to helping its clients develop a culture of persistent student success improvement, based on the following seven principles[19]

1. **Turning Your Own Lights On: Moving from "Best Practicism" to Student Success Science -** Moving away from one-size-fits-all, facile recommendations (based on best practices at other institutions or federations) to a richer understanding of your students, their pathways, and how successfully they are engaging with your policies and practices. There is no single model that fits all.

2. **Predictive Models are Powerful, But Only a Predicate: Adopting a Try and Test Mentality -** Moving from autopsy data to operation data to predictive data is a must. It outfits us to help intervene and inspire in real time, and ahead of time. However, these data are only a predicate. You now have to do the work of trying and testing the strategies to inspire and intervene.

3. **From Nice-to-Have to Mission-Critical -** More institutions are developing infrastructures and teams to drive educational analytics strategy, and it's moving beyond just reporting, accreditation, and planning. These efforts are becoming core to how the organization operates day to day. From early warning systems to weekly stat-chats, analytics are becoming mission critical daily resources.

4. **The Way Matters More: Design Thinking is needed for the Front Lines of Learning -** You can be dead right and lose badly with data. It's all in how we get the data to the front lines in compelling and useful ways that can guide reimaging our practices. We need to redesign many aspects of our student success processes using the principles of design thinking.

5. **Hot Topics Heating Up the Conversations -** It is imperative to create a climate of reflective practice around student success by provoking conversations such as: Toxic and synergistic course conversations, non-cog and student agency, combining adaptive pathways with adaptive learning, and course scheduling based on completion optimization.

6. **Analytics Can Catalyze or be Crushed by Systems and Culture -** The best analytics systems need to work well within the operational and social context in which they are deployed. At best they reflect and assist the systems and culture as they strive to improve. At worst, they can be thwarted by restrictive policy or active cultural immune systems. The focus on action analytics over accountability analytics seems key.

7. **Leadership and Learning Shifts in the Age of Analytics -** Presidents and Provosts now need to be literate in analytics, just as they recently had to develop technology literacy. Moreover, at some

institutions there is a need for a next-gen Chief Analytics Strategy Officer (CASO). In addition, folks on the front lines are going to have to adjust to using these tools as part of the learning journey, especially with new learning models coming into the mix such as competency-based learning, MOOCs, and more sophisticated blended learning.

> "The new generation of analytics capabilities is creating a new breed of "student success scientists."
>
> Mark David Milliron

VI. What's next in Student Success Optimization?

We are poised on the cusp of substantial changes in the technologies, tools, and practices of student success analytics. For example, consider the following forces:

- **Increasing Applicability of Accountability Analytics and Performance Funding -** Accountability statistics and performance funding will grow in importance among policy makers and funders at local, state, and federal levels. Regional accrediting agencies are focused on improving student persistence and success.

- **Continuing Growth in Student Success Best Practices -** More and more proven "best practices" like those promoted by Complete College America, Completion by Design, and the John Gardner's Institute for Excellence in Undergraduate Education will be made available to and deployed by institutions to improve their performance and accountability statistics.

- **Development of DIY Analytics and Visualization Tools -** Vendors will provide voice activated, user-friendly analytics tools enabling "predictive analytics for the masses" and enhanced visualization. These tools will improve the capacity of institutions to enhance their own analytics offerings.

- **Growth in Personalized and Competence-Based Learning -** The continuing development and market penetration of competence-based and personalized learning with embedded analytics, in individual courses and MOOCs, will enrich the complexity of student success analytics.

- **Next Generation Digital Learning Environments -** The emergence of cloud-based, NGDLE will support "connected learning" and increase the complexity of managing student success. This will focus on increasing integration of data, customer-friendly access and use of data. It will also provide improved cost and functionality, which will enable reduction in the costs of administrative systems and increasing investment in academic systems[20]

- **Emerging Competence Marketplaces.** As competence-based learning penetrates the learning marketplace, competence marketplaces will emerge. They will be mechanisms where the competence requirements of jobs are made public and influence the preparation of learners and the behavior of employers. As described by Ryan Craig and Allison Williams in "Data, Technology and the Great Unbundling in Higher Education"[21], LinkedIn is in the process of executing its strategic

intent of positioning itself to serve as a competence marketplace for the 3 billion plus members of global work force. It is developing software tools and interfaces to parse and match competencies from job descriptions and resumes and interface tools to bring these offerings to its audience – including many college and university students. Colleges and universities will be part of this learning, competence, and employment ecosystem.

As they evolve, competence marketplaces will influence the choices, pathways, and knowledge gap decisions of many learners; the behavioral patterns and choices of future learners are likely to be very different from today.

These developments will likely have the following outcomes on the seven dimensions of student success optimization.

Table 3. Seven Dimensions of Student Success Optimization

Dimension	Future Developments
1. Managing the Pipeline	Greater use of predictive and prescriptive analytics, embedded in strategic enrollment management at all stages of the student pipeline/life cycle.
2. Eliminating bottlenecks, barriers, deploying best practices	Increased adoption of proven best practices such as those advanced by Complete College America, Completion by Design and the John Gardner's Institute for Excellence in Undergraduate Education especially by institutions without developed analytics practices.
3. Dynamic intervention	The use of dynamic intervention based on predictive and prescriptive analytics will grow. These capabilities will be actively embedded in next gen IPAS systems and practices.
4. Integrated Planning and Advising Systems (IPAS)	IPAS will continue to develop in sophistication and comprehensiveness. IPAS will need to deal with increasingly complex combinations of learning and guided pathways. IPAS will also need to incorporate co-curricular and employment experiences. Many new solution providers will be attracted to the IPAS space.
5. Next Gen Learning	The emergence of Next Generation Digital Learning Environments (NGDLE) will enhance the capacity of institutions to participate in Connected Learning and to manage the loose coupling of personalized and competence-based learning with content repositories and embedded analytics.
6. Data Science	Data science practices will be utilized to enrich the practice of Student Success Analytics. These applications will be used to enhance the practice of all dimensions of the student success optimization framework.
7. Academic and Employability Success	Employability and career factors will increasingly be utilized in IPAS as will managing learner's co-curricular and work experiences. Early advising on career will also be integrated into IPAS. The emergence of "Competence Marketplaces" will show learners the competences they need to fulfill job requirements posted by providers such as LinkedIn and these will influence employability advising and learner choices. This will stimulate "free-range learning" by individual learners to extend their competence portfolio beyond those available through degree programs.
Overall: Optimization of Student Success	Institutions will intentionally focus on "Connecting the Dots" and leveraging all of the elements of student success analytics, thereby optimizing student success and elevating it to the level on institutional strategic imperative.

VII. Call to Action for Leadership in the Age of Analytics

The rapidly changing landscape of higher education requires leadership that understands change, culture, collaboration and transformation. Leaders need more understanding of the role data and analytics play in supporting targeted change, including improving student progress and success. Leaders need to courageously articulate and follow through on bold courses of action to elevate student success optimization to an institutional imperative.

Articulate a Bold Vision for Student Success as "Mission Critical." If you don't know where you're going, any road will get you there. In the article "No More Excuses"[22], Michael Crow reflects on setting a bold vision for the future of Arizona State University. This built on his goal of transforming ASU into what he calls a "New American University" – an institution combining the highest levels of academic excellence, inclusiveness to a broad demographic, and maximum societal impact. His view included increasing graduate numbers, graduation rates, and freshman-retention rates while also expanding ethnic and economic diversity. Ten years later, ASU had met and exceeded the goals with significant increases in enrollment, up over 30% since 2002; increase in minority enrollment by 52%; and an increase of freshman persistence of 9%. In addition, the number of first-time, full-time, low-income Arizona freshmen increased 647 percent from FY2003 through FY2011[22].

Many presidents – at research universities, comprehensive universities, community colleges, and liberal arts colleges – also have improved student success and reduced achievement gaps through bold vision backed up with people, resources, and programming that are proven to improve student persistence.

> Optimizing student success should be Institutional Strategy #1. Effective change management should be deployed to execute this strategy and build the organizational capacity required for its success.
>
> Linda Baer and Donald Norris

Raise the "Student Success Analytics IQ" of Leaders and Everyone in the Institution
Leaders need to become highly familiar with analytics concepts and capabilities. They need to embrace student success science, which represents some of the best thinking in student success in decades. This field is bringing together the best in student success theory and practice with deep data and predictive modeling to maximize options and opportunities for decision makers. We find ourselves at a teachable moment where "optimizing student success" may become a reality, with everyone from executive leadership to front-line faculty and staff playing roles in delivering on that promise.

Nurture Partnerships, Collaborations, Sharing, and Solution Providers in Your Analytics Strategy
The advances in student success analytics are being enabled by pervasive sharing of talent, best practices, and know-how. They also are encouraging new solution providers and familiar vendors working to deliver new applications and support services. Leading institutions are sharing their accomplishments with peers and forming consortia to share best practices and create federated data systems that can reveal insights that were previously unobtainable[23].Sharing and collaboration will be critical in achieving analytics strategies at affordable costs.

"Connect the Dots" across the Institution and Build Organizational Analytics Capacity

In most institutions, data and student success analytics capabilities and responsibilities are fragmented. This can be corrected by developing a formal institutional analytics strategy to "Connect the Dots" across all the dimensions of student success optimization. The model can take the form of an Office of Institutional Analytics or be incorporated into the student success initiatives. This can result in a clear plan and roadmap. This plan should articulate how we know "what works" for improving student persistence and success, allowing leaders to focus on the combination of best practices and personalized interventions that provide the maximum return on investment. The planning process begins with a cross-institutional review of where the institution is in terms of data use, analytics reporting, predictive modeling, and prescriptive follow-through. The nature of partnerships, collaborations and solution provider relationships should also be assessed. These all require careful assessment of human resources, skills and competencies, fiscal investment, and infrastructure capacities. This builds the foundation for how the institution will move forward over a 3-5 year period of investment, strengthening capacities, and impact for improved use of data and analytics.

Building capacity will necessitate substantial acquisition and development of skilled talent. Perhaps the greatest challenge to institutions will be to combine collaboration, partnerships, sharing, and development of internal talent to build an analytics-able workforce in higher education.

Connecting the dots is important because it allows leaders to leverage what is going on to move to where the work on student persistence and completion must move for future student success. Dots need to be connected:

- Across the student learning life cycle;
- Across the data infrastructure and platforms;
- Across the ecosystem of partners within the campus and across those involved in the student learning life cycle;
- Across the tools that enable optimization of student success; and
- Across theories and practices and data and predictive modeling in student success science.

These connections provide the organizational glue to make Optimizing Student Success a coherent, pervasive institutional strategy.

Empower Cross-Campus Teams that Act to Improve Student Success

Cross-campus teams are important to optimizing student success. Cross-campus teams should also reach other institutions, K-12, and employers. This collaboration begins by working with high schools to improve student course-taking behaviors that lead to college readiness. It then moves to building dual enrollment programs to encourage students to begin taking college credit early and often. Advancing this idea to transfer and articulation agreements across colleges and universities; agreements that really work for students! This also includes deep conversations with businesses, industries, and stakeholders who benefit from strong college and university graduates. Leaders must lead in the conversations and expectations that cross team and institutional decisions will be made.

Build Support Systems for Student Success Using Student Success Science

Identify best-in-class student support services and evaluate where the campus is in providing them. Student support services staff need to be trained in institutionally-grounded best practices. They should also be given the authority and responsibility to develop new services, evaluate the services for outcomes and

benefits to the student and the institution, and provided with the tools and technology to maximize services to students on site, online and in mobile formats. They need to understand and use data sources to improve decision-making. Student success science enables campuses to merge the power of best theory and practice in student persistence and success with the best data and predictive models that result in best support services in a timely manner to optimize student success. This will require investment of time, talent and resources to be strategic and sustainable.

Build a Culture of Student Success Improvement

Peter Drucker famously observed that "Culture eats strategy for breakfast" (which he later changed to "lunch"). Without proper attention to cultural change, student success analytics strategies will flounder. Great leaders know how to build a culture of urgency throughout the institution. Accreditation can be leveraged to create a centerpiece for many sustained activities on campus through linkages between planning, culture, and sustainable change. Leaders should have a change management plan in place with a comprehensive communication plan to allow the campus and stakeholders to clearly understand the nature of the change, the impact of the change, have a say and participate in articulating the change, and owning the results.

Deploy Design Thinking to Reinvent Student Success Practices

Achieving a culture of student success improvement can be accelerated by deploying design thinking principles and practices to reinvent our approach to student success. Design thinking uses prototyping, research, and learner-centric planning. It focuses on simplifying and humanizing institutional processes and practices on the way to optimizing student success. Design thinking must be a core competence of an organization whose culture is truly focused on student success (23).

> "Once confined to product development, design thinking has become central to strategy, innovation, and organizational culture."
>
> Jon Kolko, "Design Thinking Comes of Age."

Demonstrate the ROI from Analytics and Next Generation Technologies

Institutional leaders face the challenge of investing in student success analytics in a time of tight resources and substantial institutional investments in transactional ERP and LMS systems that have failed to provide data and analytics breakthroughs. Student success analytics can be shown to have a highly favorable ROI when they yield improvements in student success. Through collaboration, partnering, and sharing, institutions can drive down the cost of new analytics capabilities. Moreover, in investigating NGDLE, institutions should do so with an eye to reducing the costs of transactional administrative systems and reinvesting those savings in analytics and new learning technologies.

Lead and Thrive in the Age of Analytics. The award winners in the Aspen Prize for Community Colleges were innovative colleges with courageous leaders[25]. These leaders created urgency for student success by taking ownership of failure, shifting focus to what matters most, planning for big change, and allocating resources for student success, understanding that college is not a destination but part of the learner's larger road map, and choosing and developing leaders.

Such leadership requires aggressively building team competencies. It may require creating new positions

such as the Chief Analytics Strategy Officer (CASO). Leading means supporting data system development, maximizing team capacities to deliver insights from the data, communicating activities and outcomes on a regular basis, and making analytics a part of building and sustaining a strong future for students and the institution.

Thriving in our disruptive times requires a combination of leadership, strategy, innovation, and performance excellence. Embracing student success analytics provides the opportunity for institutional leaders to achieve this combination.

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