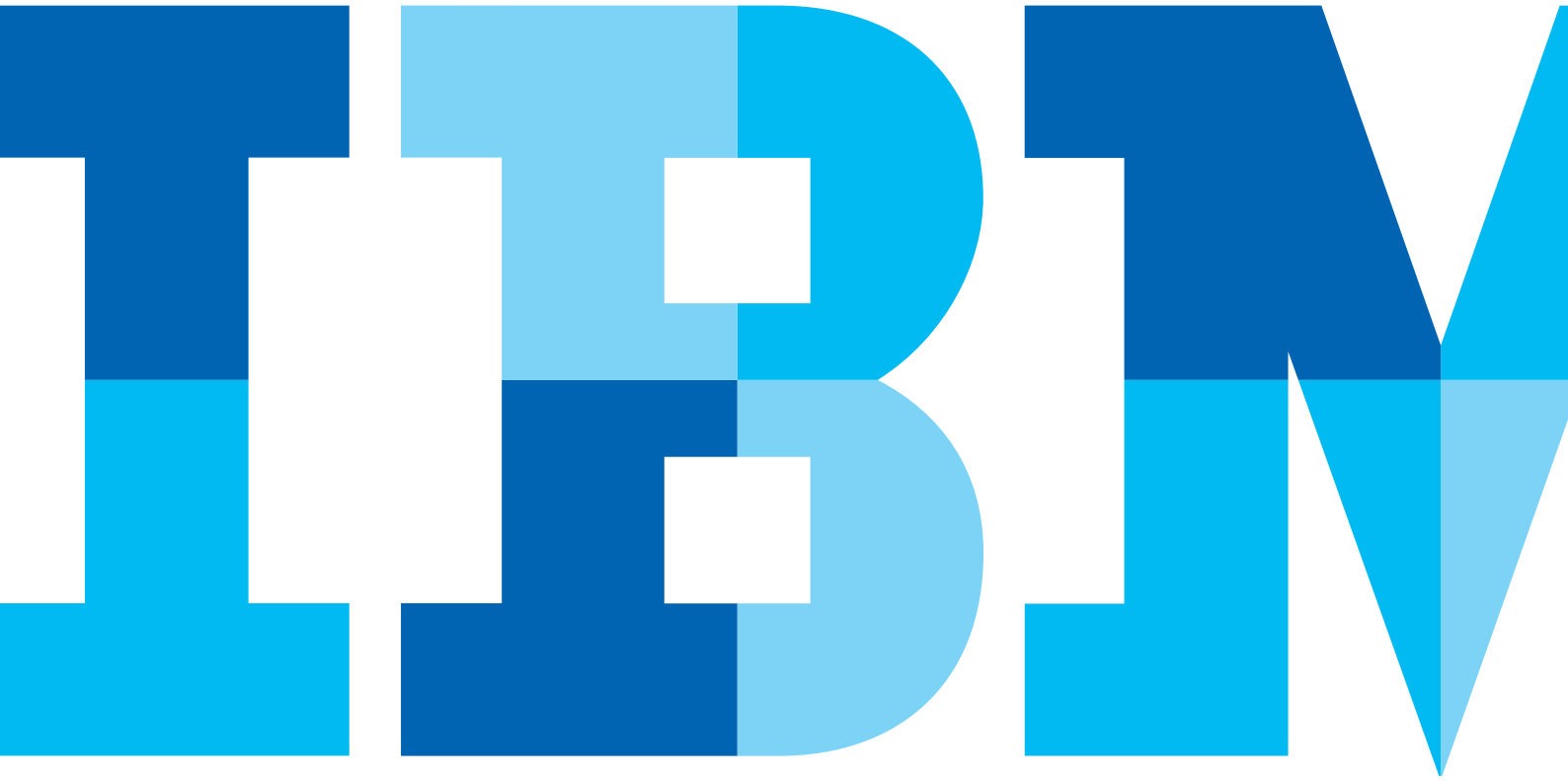
IBM Software Group
White Paper

Analytics for Achievement

Understand success and boost performance in primary and secondary education



Abstract

Around the world, in both developing and developed countries, too many primary and secondary students are falling below proficiency levels. Measuring and monitoring performance and understanding the factors at play in student achievement can help educators create the right conditions and design the most effective interventions for student success.

Overview

Few would dispute that education paves the way to prosperity, both personal and societal. The ills of developing countries — poverty, unemployment, poor health, high crime — can all be combated through education. And while education has the power to lift people out of poverty, it also helps us live fuller lives, make wiser choices and contribute to our communities in more meaningful ways. Education creates equality by opening up opportunities to everyone, not just those with privileged backgrounds.

Happily, most countries recognize the importance of investing in high-quality education. The United States for its part has increased investment in primary and secondary education by 40 percent over the last decade. But despite being one of the biggest education spenders on a global scale, the country has not seen student achievement significantly improve. Right now, only 39 percent of fourth graders in the U.S. are proficient in math; only 33 percent in reading.[1]

High stakes: Recent McKinsey research found that "an ongoing achievement gap between US students and those in academically top-performing countries imposes the economic equivalent of a permanent national recession."[2]

Throughout the world, many adults struggle with basic reading, math and scientific literacy. Drop out rates are unacceptably high in many countries. Teachers, politicians, legislators, employers, administrators, parents and even students want to understand the factors at play in improving student achievement. Why do some students succeed while others fail? Why do some students stay in school while others drop out? Why do we see such dramatic swings in performance? Educators are eager to respond and make changes, but many are unsure of where to start.

[1] Green, Elizabeth. "Building a Better Teacher." *The New York Times Magazine.* March 2, 2010. http://www.nytimes.com/2010/03/07/magazine/07Teachers-t.html?_r=1&scp=1&sq=elizabeth+green&st=nyt

[2] McKinsey Quarterly. "Attracting and retaining top talent in US teaching." September 2010. https://www.mckinseyquarterly.com/Public_Sector/Education/Attracting_and_retaining_top_talent_in_US_teaching_2673

The achievers

Given the clear need for better results, how can institutions respond? Some feel the answer lies in examining the models of high achieving countries.

When it comes to performance, countries such as South Korea, Finland and Japan consistently outrank others. On the OECD's 2009 PISA assessment of 15-year-olds in reading, math and science literacy in 60 countries, South Korea and Finland rank first and second. But they are also notable for their low per-pupil spending. So if they're not spending, what are they doing right?

The Finnish approach, which has remained remarkably unchanged for over 30 years, works across demographics: low- and high-performing schools differ by only 4%. Early learning comes through play; students only start formal school at age seven. Teachers, all with graduate degrees, enjoy high prestige and relative autonomy. Small schools create strong relationships and an informal atmosphere. Teachers ensure early and energetic intervention for struggling pupils.

The question is: which strategies are key to success? For example, many feel small class sizes will raise results across the board. But this argument falls apart in South Korea, where the average class size of 35 (the highest in the world) does not seem to harm student performance.

The UK is setting a course of action based on Finland's successful model. The country plans to raise the status of the teaching profession, give schools more autonomy, ensure stronger accountability and instil a strong sense of aspiration for all children, whatever their background.[3] Similarly, the US is focussing on more effective teachers and principals, more family involvement in schools, college- and career-ready standards and support for low-performing schools.[4]

Getting to better performance

Student achievement is a result of a complex interplay of many variables. Background, curriculum, testing style, funding, class size and school size are just some of the possible factors behind performance. But when data is scattered across an organization in paper files or spreadsheets, solving the puzzle of success and failure is next to impossible. Many schools, boards and districts are turning to analytics to combine and analyze their own data, asking and answering such questions as:

- What are the leading indicators of and reasons behind low performance?
- Which efforts, investments and factors affect student success?
- How do attendance, involvement and discipline events relate to performance?
- How much should we invest in teacher development? In interventions?

[3] UK Department for Education. "The Importance of Teaching: Schools White Paper." December 6, 2010. http://www.education.gov.uk/schools/teachingandlearning/schoolswhitepaper

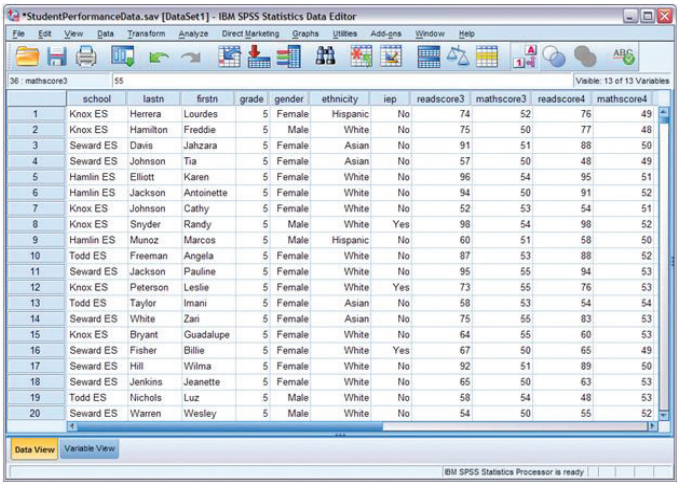
[4] US Department of Education. "ESEA Blueprint for Reform." http://www2.ed.gov/policy/elsec/leg/blueprint/publicationtoc.html

Answering questions from a wide range of areas can help provide the insight needed to keep what is working, and make meaningful changes to what is not. This paper sets out eight areas ripe for measuring, monitoring, analyzing and changing to optimize student performance. These areas include:

1. Measuring and monitoring student achievement
2. Reporting results
3. Spotting outliers for early intervention
4. Predicting potential
5. Preventing drop-out
6. Identifying and developing key attributes of good teachers
7. Analyzing standardized testing to even out performance
8. Testing and evolving curricula

1. Measuring and monitoring student achievement

The logical first step is getting a clear picture of how students are doing and where they stand in relation to their peers both locally and globally. Analytics systems let schools view the performance data of students and groups across multiple testing events. They can compare student, school, district or board and national marks, and view and track progress by class, cohort, teacher, course or program. Better insight into student performance is the first step in unlocking student potential.



	school	lastn	firstn	grade	gender	ethnicity	iep	readscore3	mathscore3	readscore4	mathscore4
1	Knox ES	Herrera	Lourdes	5	Female	Hispanic	No	74	52	76	49
2	Knox ES	Hamilton	Freddie	5	Male	White	No	75	50	77	48
3	Seward ES	Davis	Jahzara	5	Female	Asian	No	91	51	88	50
4	Seward ES	Johnson	Tia	5	Female	Asian	No	57	50	48	49
5	Hamlin ES	Elliott	Karen	5	Female	White	No	96	54	95	51
6	Hamlin ES	Jackson	Antoinette	5	Female	White	No	94	50	91	52
7	Knox ES	Johnson	Cathy	5	Female	White	No	52	53	54	51
8	Knox ES	Snyder	Randy	5	Male	White	Yes	98	54	98	52
9	Hamlin ES	Munoz	Marcos	5	Male	Hispanic	No	60	51	58	50
10	Todd ES	Freeman	Angela	5	Female	White	No	87	53	88	52
11	Seward ES	Jackson	Pauline	5	Female	White	No	95	55	94	53
12	Knox ES	Peterson	Leslie	5	Female	White	Yes	73	55	76	53
13	Todd ES	Taylor	Imani	5	Female	Asian	No	58	53	54	54
14	Seward ES	White	Zari	5	Female	Asian	No	75	55	83	53
15	Knox ES	Bryant	Guadalupe	5	Female	White	No	64	55	60	53
16	Seward ES	Fisher	Billie	5	Female	White	Yes	67	50	65	49
17	Seward ES	Hill	Wilma	5	Female	White	No	92	51	89	50
18	Seward ES	Jenkins	Jeanette	5	Female	White	No	65	50	63	53
19	Todd ES	Nichols	Luz	5	Male	White	No	58	54	48	53
20	Seward ES	Warren	Wesley	5	Male	White	No	54	50	55	52

Follow student scores and trends in math and reading by school or grade.

Educators are also starting to create individual student records that follow a student through life, containing all information from results to attendance. Students and parents can view their own information through different levels of security access. When teachers and analysts can access the lifetime picture of a student's progress, performance against cohort, trends and most and least proficient subjects, they can ensure students will consistently progress and reach potential.

2. Reporting results

Reporting student achievement is a common requirement for educational organizations of all levels. Whether a function of law, funding or public relations, school boards and districts must be able to gather results data and report on it at various levels, often by demographic slices such as gender, economic status and language proficiency.

Analytics lets educators drill into special population segments, explore individual attributes and understand factors in the success or failure of an educational initiative. Analytics helps make mandatory compliance reporting significantly easier, especially as it relates to obtaining public funding.

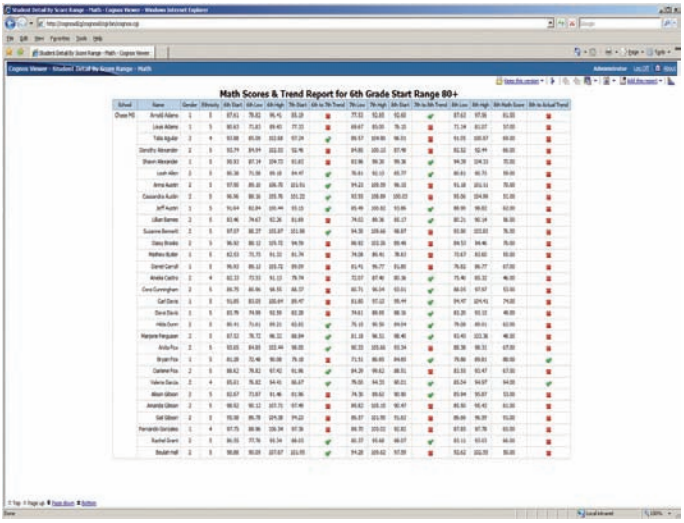
3. Spotting outliers for early intervention

One of the most effective tools at hand for schools to improve overall performance is early intervention for outliers: both at-risk students and very high performing students.

Catching and supporting low performers

Teachers have no trouble spotting students who are struggling to keep up and providing the extra help needed. More difficult for busy educators is spotting the average or excellent students who suddenly find themselves in a downward spiral, as a result of circumstances at school or at home. Both kinds of underperformers need help.

The trick is to spot low or falling performance early enough to do something about it. Schools often lack the resources to follow an individual student's progress across subjects from year to year. Strong measurement of student performance year after year, combined with predictive analytics, can help highlight factors indicating a downward turn in performance. This combination of past- and future-looking visibility supports early intervention for underperforming students.



Educators can follow achievement through green or red indicators and drill down into individual scores.

Because test scores alone may not tell the whole story, predictive analytics can forecast likely results based on individual past performance and generalized trends. For students lagging behind predictions or minimum success standards, analysts can delve into factors that may be affecting the student's performance, such as teacher or feeder school.

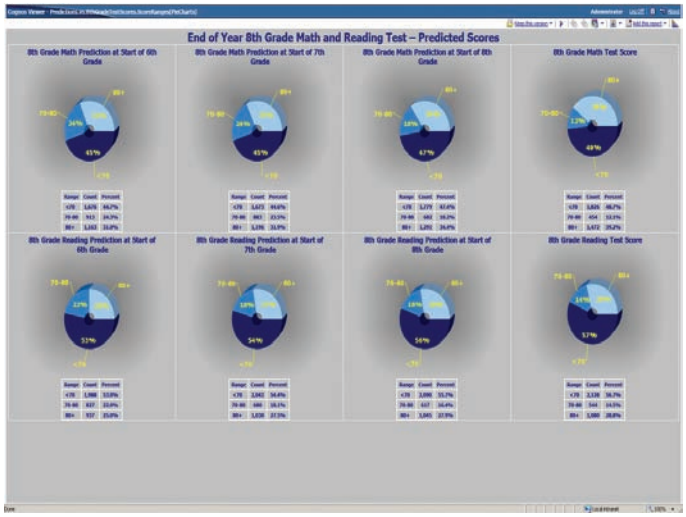
Boosting top performers

Schools focus heavily on students falling behind; but they should also look out for students excelling beyond their level. Top performers are always in danger of getting bored and falling behind or dropping out. Outperformers need to remain motivated and maintain a continued interest in learning.

Monitoring performance thresholds for these exceptions at the district or board level can help back up teacher instinct and intervene to ensure these students do not fall through the cracks. Analytics can also help educators measure how well their interventions worked — with an individual or across a school, cohort or region.

4. Predicting potential

It is natural that schools focus on the outliers, but what about the average student? Educators want to see all students fulfill their potential and prepare for their post-secondary stage. Predictive analytics uses student data to reveal patterns that suggest how individual students should be performing. If a student is achieving below predicted, teachers and parents can proactively intervene to uncover causes and offer encouragement to focus harder.



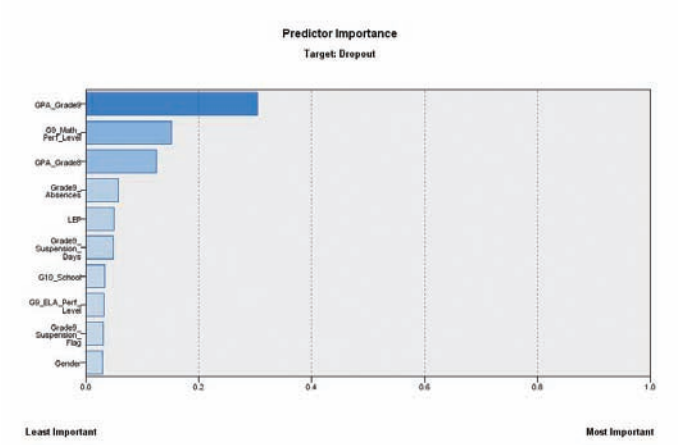
Use previous scores to predict what outcomes should be.

5. Preventing drop-out

In most countries, students who finish high school and finish a degree can double their earning potential. But despite the obvious benefits of graduation, millions of students still drop out before completing high school. In some areas of rural Canada, 20 percent of students do not graduate from high school. In the US, the trend is reversed, with drop-out rates of 30 percent in many cities. The UK is faring no better, with an overall rate of 24 percent (2006). In India, 40 percent of students drop out before grade five. By contrast, in South Korea, 97 percent of young adults complete high school, the highest recorded in any country.[5]

"Sixty-five percent of U.S. convicts are high school dropouts."[6]

The high correlation between school abandonment, reduced income and criminal activity has prompted educators to look for causes and plan solutions. Theorists have identified a range of warning signs that can point to the need for intervention. Grades, attendance and involvement in school activities are all indicators.



Low involvement, attendance and grades are important predictors of drop-out.

Americans Allensworth and Easton suggest this rough timeline for monitoring and intervention:

Schools can start in the first quarter with monitoring and addressing absences, then address first-quarter failing grades by offering immediate support. As semester grades are posted, the creation of individual dropout strategies would be called for. The end of the year would show who is at high risk for dropping out, and one-on-one interventions could then be intensified.[7]

[5] "South Korea's education success." BBC News. September 13, 2005.

[6] The Broad Foundation Education website. http://www.broadeducation.org/

[7] Allensworth, E., & Easton, J. Q. "What matters for staying on-track and graduating in Chicago Public High Schools: A close look at course grades, failures and attendance in the freshman year." Chicago: Consortium on Chicago School Research, 2007.

Once schools identify the risks for drop-out, they can intervene with the appropriate counselling or promotion of extra-curricular activities, which are known to build school community and strengthen relationships between teachers and students. If parents could be made to understand that increasing attendance by, say, 10 percent could lower their children's risk of drop-out to virtually nil, they may be more motivated to ensure their kids get to school.

6. Identifying and developing key attributes of good teachers

A recent New York Times article on the factors behind student achievement highlighted the importance of good teachers. "When researchers ran the numbers in dozens of different studies, every factor under a school's control produced just a tiny impact, except for one: which teacher the student had been assigned to."[8]

The impact on student achievement as it correlates to teachers is enormous. Using standardized tests, a Stanford economist found that while the top five percent of teachers could teach a year and a half's worth of material in one year, the weakest five percent taught only half a year of material in one year.

According to a recent McKinsey report, top performing nations such as South Korea and Finland "view their teachers as integral to their economic strategies." They "recruit 100% of their new teachers from the top third [of their class]. In the U.S., it's 23% — and 14% in high poverty schools."[9]

Analytics can help educational institutions identify, recruit and retain the best teachers and improve instructional practices across the board. Plotting grades against demographic data can highlight the teachers who are getting the highest performance out of the most disadvantaged students.[10]

Student satisfaction with their teachers also directly correlates to student success. Student feedback data can reveal satisfaction or more subjective insights into the classroom experience. Analytics systems with text mining can help reveal attitudes towards and feelings about the teacher, which can then be linked to student performance.

Understanding the key attributes of a great teacher can help a school board set standards for teacher performance and use that information to develop, recruit and retain the best teachers. Once identified, exceptional teachers can share their

[8] Green, Elizabeth, ibid.

[9] Auguste, Byron et al. "Closing the Talent Gap: Attracting and retaining top-third graduates to careers in teaching." McKinsey & Company. September 2010. http://www.mckinsey.com/clientservice/Social_Sector/our_practices/Education/Knowledge_Highlights/~/media/Reports/SSO/Closing_the_Talent_Gap_September_2010.ashx

[10] Green, Elizabeth, ibid.

practical techniques for classroom management, discipline, motivation, encouragement and teaching practices with their colleagues and their management to help all teachers have the best outcomes.

7. Analyzing standardized testing to even out performance
Standardized, area-wide and international student testing has become the norm in most countries. Like them or not, these tests are necessary as a gauge of the health of a system as well as a ticket to higher education levels. In the U.S., compliance with state proficiency standards is a growing necessity: under current policy, 100 percent of a school's students will have to reach standards by 2014 or the school will get a failing grade.

We know they are necessary, but can we make them useful? In fact, this kind of testing provides an excellent baseline for performance and can reveal opportunities for improvement. Ranking can help educators examine the factors behind performance and work harder to direct more resources to low-performing schools in an attempt to even out performance, as Finland has done across the system.

8. Testing and evolving curricula
Curricula continue to evolve in an ongoing effort to teach the best subjects in the best way. As boards introduce new elements into a curriculum, monitoring student performance and teacher acceptance of the new curricula over key periods following the introduction can help evaluate the success of the changes. Statistical evaluation helps school boards effectively test and develop new curricula in a smaller deployment and avoid pitfalls in a larger segment.

As educators have discovered that different methods work for different groups of students, predictive analytics can forecast what kind of math program will be optimal for particular groups of students and how long it will take to adopt. Evaluating the right fit for curriculum elements can save time and ensure achievement grows through customized curriculum.

Roadmap to high achievement

Moving from paper and spreadsheet records to an analytics-driven education system does not happen overnight. Organizations are advised to take small, manageable steps towards a complete system of analytics for educational institutions. When dependable data is made accessible to all stakeholders, they can start with the necessary stage of compiling student results to build a baseline. Along the way, data users must have training on how to use and analyze data to build effective interventions.

Step One: Measure current state of achievement
The first step in any improvement effort is setting a baseline: knowing how your students are doing and where they stand in relation to peers. Using analytics, educators can measure and continue to monitor student achievement by combining standardized or regional tests and class grades. They may also measure and monitor soft skills such as problem-solving ability, independence and teamwork. Analytics also helps you report on your current situation to your stakeholders.

Step Two: Set achievement goals
Where do you need to go? Could you strive for a five percent increase in grades over five years? Do your students have the potential to be the top performers in your region? Do you need to cut drop-outs in half by the end of the decade? Analytics systems help you create strategy maps to record ambitious but achievable goals and the steps to reach them.

Step Three: Determine strategies for reaching goals
Deciding how to influence success is the most challenging element. What levers will you adjust to ensure every student lives up to potential? Will factors outside of your influence — such as socio-economic background and home life — hold back achievement, or can interventions level the playing field? Multidimensional analysis can help you track and influence other variables such as class or school size, teacher certification and salary, per-pupil funding, attendance rates, discipline events, instructional evaluations and curriculum. Predictive analytics helps you identify critical patterns in data to spot anomalies, intervene early and improve performance. Your action plan may include adjusting curriculum, creating special programs, changing the teaching approach or larger scale strategies that tie into national testing.

Step Four: Measure progress and evaluate strategy
Follow your progress towards results through scorecarding and understand how interventions are affecting students both in terms of academic performance and high school completion. Prioritize and calibrate your interventions to drive student achievement.

Analytics for Education

Student achievement is just a part of an educational organization's overall analytics strategy, which includes:

- Mission goals
  - Tie long-term goals to executable, measurable strategy
  - Translate strategy to specific objectives
  - Link all programs and budgets together with goals and strategy

- Academic performance
  - Measure and monitor student progress
  - Measure and monitor teaching progress
  - Manage curriculum and other learning activities

- Financial objectives
  - Align budgets and resources
  - Redeploy dollars to meet critical objectives
  - Manage operational and IT costs

- Operational requirements
  - Reduce data uncertainty, increase transparency
  - Link strategies, goals and outcomes together
  - Demonstrate transparency and accountability.

An analytics-driven organization can ensure operations and funding support student achievement and the strategic mission.

Conclusion

Institutions are feeling pressure from many different directions to improve student performance. Primary and secondary education organizations face legal and statutory demands for better performance, as well as pressure from parents. Drop-outs and undereducated graduates can hurt not only an institution's reputation, but also, in today's results-oriented funding climate, its bottom line.

Creating a roadmap to analytics is the first step in becoming a data-driven education organization. Analytics can help educators understand how their students are performing, why, and how to get better. Teachers can make the most of the time they have with students, and organizations can fine-tune methods to build on success. Students can fulfill their potential and make a meaningful contribution in their field of choice.

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Produced in Canada
February 2011

P25851

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