Building a Data-Driven Education System in the United States

By Joshua New | November 15, 2016

Schools today are not very different from 50 years ago. Instructors still teach to the average, rather than provide students personalized instruction, because it is expedient, not because it is effective. Most educators still rely on tradition and rules of thumb, rather than use evidenced-based tools and methods to advance student achievement. And most administrators still make decisions, often inaccurately, based on assumptions and intuition, rather than use detailed metrics and analytics to manage schools efficiently and fairly. In short, while most Americans are empowered by data and technology in many aspects of their lives, U.S. schools are largely failing to use data to transform and improve education, even though better use of data has the potential to significantly improve how educators teach children and how administrators manage schools.[1]

The United States now has an opportunity to rebuild its education system to support data-driven education by taking advantage of technologies and best practices already established in other sectors.

Though some industries have completely restructured their operations around the new opportunities afforded by data-driven technologies, education has yet to undergo such a transformation to capitalize on the potential of data. Although information technology (IT) has entered most U.S. classrooms, with 93 percent of teachers regularly using digital tools to assist classroom instruction in some capacity, schools still focus on using IT to support operations, rather than leverage data to transform and improve these operations.[2] The reasons for this range from inadequate teacher training to systemic limitations in how states manage their education technology infrastructure. In addition, misinformed and ill-conceived opposition to improving how the education system uses data routinely limits policymakers and educators from making meaningful progress. For example, a common misperception is that increasing the collection and use of data in the

classroom would increase the much-loathed annual standardized testing, when in reality, data-driven education would reduce reliance on such ineffective methods of student and teacher assessment.

If the education system's sluggish recognition of the potential of data has a silver lining, it is this: The United States now has an opportunity to rebuild its education system to support data-driven education by taking advantage of technologies and best practices already established in other sectors. To do this, the U.S. education system, from local school districts to the federal government, should systematically implement the policies, practices, and technologies that enable data-driven education. A data-driven education system should achieve four main goals:

- Personalization: Teachers tailor lesson plans, educational materials, and assessments to meet the unique needs of each student. Rather than being forced to "teach to the test," instructors will be empowered to "teach to the student." Educators dynamically adjust instruction to accommodate students' individual strengths and weaknesses rather than continue to utilize a mass production-style approach. No child should be struggling to keep up or bored in the classroom because the lessons they are being taught are at the wrong level for them.

- Evidence-Based Learning: Teachers and administrators make decisions about how to operate classrooms and schools informed by a wealth of data about individual and aggregate student needs, from both their own students as well as those in comparable schools across the nation. Classroom decisions are influenced by data showing what does and does not work rather than by intuition, tradition, and bias.

- School Efficiency: Educators and administrators use rich insight from data to explore the relationships between student achievement, teacher performance, and administrative decisions to more effectively allocate resources. School operations are transparent, allowing better oversight and management so that administrators can eliminate ineffective practices.

- Continuous Innovation: All education stakeholders have streamlined access to useful and usable education data that can serve as a powerful platform for improvement and innovation. Researchers, educators, parents, policymakers, tech developers, and others can build valuable and widely available new education products and services to uncover new insights, make more informed decisions, and continuously improve the education system.

And all of this can and should be done in ways that protect individual student privacy.

Failure to transform the U.S. education system by leveraging data will have considerable consequences not just for individual students and taxpayers, but for U.S. productivity growth and competitiveness. Without a more effective education system, productivity will grow more slowly and organizations will have a harder time getting the workforce they need.[3]

As these demands on the education system increase, its capacity to rise to these challenges has not. Though recent years have seen some progress, such as rising graduation rates, the overall effectiveness of the education system has increased slowly, if at all.[4]

Policymakers should take the following steps to build a data-driven education system:

- Encourage smarter data collection and management: Federal and state departments of education and school administrators should establish practices for collecting, storing, managing, analyzing, and sharing data that maximize their value for education.
- Encourage data system interoperability: Federal and state policymakers should require the use of tools and systems that can seamlessly share data with all education stakeholders to allow educators to put data to good use.
- Empower students and parents with access to their data: School districts should make student data easy to export, so parents can be more involved in their child's education and so that their data can help the private sector build new and valuable education products and services.
- Promote data-driven decision-making: State departments of education and school administrators should provide educators with the tools, training, and incentive to use data to improve educational outcomes.
- Push back against unfounded privacy fears: Policymakers should ensure that educators use data responsibly but oppose advocacy fueled by unsubstantiated fears that supports counterproductive restrictions governing how educators can collect, use, and share data.
- Develop a model data-driven school district: The U.S. Department of Education should launch a pilot program that helps a school district adopt the latest in data-driven education

technology and best practices to demonstrate the potential of data to policymakers and educators.

- Use data to promote equity in education: Policymakers and school administrators should implement data-driven strategies to address the longstanding socioeconomic and demographic disparities in educational outcomes.

THE NEED TO IMPROVE THE U.S. EDUCATION SYSTEM

There are two main shortcomings of the education system in the United States: inadequate performance and educational disparities.

INADEQUATE PERFORMANCE

The Department of Education's National Assessment of Educational Progress (NAEP) assesses student performance over time across multiple subject areas. Though student performance has increased slightly over the past 25 years, only a small minority of students are considered proficient in any subject in the 4th, 8th, and 12th grades.[5] NAEP's data on how student progress has changed over time also reveal that, except in mathematics for 4th and 8th graders, in which students have shown a considerable increase in proficiency since 1990, levels of student achievement have increased only slightly, stagnated, and even declined in some areas in the past two decades.[6] For example, 12th graders in 2015 performed approximately the same in mathematics as did 12th graders in 2005, and actually performed worse at reading than 12th graders did in 1992.[7]

Table 1: Percentage of U.S. Students At or Above "Proficient" Level By Grade Level

Subject	Grade 4	Grade 8	Grade 12
Geography	21% (2010)	27% (2014)	20% (2010)
Mathematics	40% (2015)	33% (2015)	25% (2015)
Reading	36% (2015)	34% (2015)	37% (2015)
Science	34% (2009)	32% (2011)	21% (2009)
U.S. History	20% (2010)	18% (2014)	12% (2010)

Note: Years in parentheses indicate the most recent year for which data are available.
Source: National Assessment of Educational Progress – Nation's Report Card.

Even students who are proficient or superior in their educational attainment may not be getting the educational experiences they need in order to take full advantage of their capabilities. All too often, as long as students meet expected standards of proficiency, their needs to improve and do even better are ignored. Moreover, there is considerable divergence by state in the educational programs tailored to gifted students.[8] Because teachers must teach to the average of a classroom, high-performing students are held back just as low-performing students

DISPARITIES IN EDUCATIONAL OUTCOMES

There is a significant difference in educational achievement for children of low-income families compared to those of high-income families, and this achievement gap has been widening for at least 50 years.[9] This achievement gap is 30-40 percent larger for children born in 2001 than it was for children born in 1975.[10] For the 2012-2013 school year, 51 percent of students in public school were low-income students, meaning the majority of U.S. students are likely to underperform because of their socioeconomic status.[11] This problem is further exacerbated by the fact that many of these students attend schools least equipped with the resources, teachers, and training to meet their needs.[12]

There are also considerable racial disparities in educational achievement, as well as in disciplinary actions, and access to advanced educational opportunities.[13] Though the national high school graduation rate for the 2013-2014 school year was a record high, at 82 percent, certain student demographic groups had notably lower graduation rates.[14] The graduate rates for American Indian and Alaska Natives, Hispanics, and Blacks were 69.6 percent, 76.3 percent, and 72.5 percent, respectively. Additionally, Black students are 3.8 times more likely to receive an out-of-school suspension than white students.[15] And in high school, 81 percent of Asian-American students and 71 percent of White students have access to a full range of math and science courses, while only 67 percent of Latino students, 57 percent of Black students, and less than 50 percent of American Indian and Native Alaskans have access to a full range of these courses.[16]

Based on NAEP's most recent analysis, in 2007, White students on average had higher scores than Black students on all assessments– based on a 0-500-point scale, in every subject White students had average scores at least 26 points higher than Black students.[17] In 2011, White students on average had higher scores across all subjects than Hispanic students as well.[18] Additionally, from approximately 1990 to approximately 2015, in many areas little progress has been made at reducing these achievement gaps.[19]

Table 2: Changes in White-Black and White-Hispanic Achievement Gaps: 1995 – 2015

Subject	White-Black Achievement Gap	White-Hispanic Achievement Gap
Mathematics		
4th Grade	Decreased	No significant change
8th Grade	No significant change	No significant change
12th Grade	No significant change	No significant change
Reading		
4th Grade	Decreased	No significant change
8th Grade	No significant change	Decreased
12th Grade	Increased	No significant change
Science		
4th Grade	[No data]	[No data]
8th Grade	Decreased	Decreased
12th Grade	[No data]	[No data]

Source: National Assessment of Educational Progress – Achievement Gaps Dashboard

THE BUILDING BLOCKS OF DATA-DRIVEN EDUCATION

A truly data-driven education system will rely on a variety of data-focused education technologies (EdTech) to improve all parts of the education system. These technologies fall into three main categories: student information systems, learning management systems, and data warehouses. However, these are just the basic building blocks of data-driven education. New technologies that can use education data in innovative ways, such as machine learning systems, will offer significant potential to improve outcomes and develop new insights into the

education process; however, educators will only be able to generate and act on these insights if they have access to a solid foundation of technologies that enable robust data collection, sharing, and use. Though many schools already utilize at least some of these technologies, they do so in only rudimentary capacities, such as to simply store data more easily rather than put this data to good use.[20] Equally importantly, many of these systems are siloed and not linked to national data analytics systems.

STUDENT INFORMATION SYSTEMS

Student information systems are digital tools designed to collect, store, analyze, and report comprehensive student records in a structured format.[21] The data used in student information systems can vary, but can include attendance, grades, disciplinary actions, extracurricular activities, health records, and more. In many cases, these tools focus on simplifying or automating routine classroom administrative practices, such as recording attendance.[22] Even just replacing pen-and-paper processes with tools that record data in digital, machine-readable formats can provide educators, students, and parents with easy access to data about student performance as well as offer considerable benefits to school and administrative efficiency and educator productivity in a variety of ways, including by making useful information more accessible, and reducing workloads.[23]

Typically, data from student information systems are aggregated into student data portals, or dashboards, which are web-based applications that integrate a variety of tools to facilitate user-friendly access to student data and can be tailored for student, educator, and parent access.[24] Student data portals can help students stay more informed about their own performance, as well as help parents monitor their child's progress and promote parental involvement, such as by calling attention to slipping grades or frequent tardiness. For educators, student data portals provide dramatically more comprehensive views of their students by aggregating data on performance, well-being, attendance, and other factors, and allow for easy monitoring and analysis.

Data in student information systems typically are drawn from traditional educational activities and practices, such as test scores or attendance. However, new technologies allow for a wider variety of useful data collection tools. For example, some schools have tested using radio frequency identification (RFID) chips in student identification cards that can record attendance, monitor when and where students board and get off school busses, and keep track of students in the event of an emergency.[25] Data from these systems can inform class schedule planning based on how students move through the schools, help parents and educators address problems with students who are frequently absent or tardy, notify parents of school bus delays, and ensure that the school can verify the safety and location of students.[26]

Robust student information systems can also allow educators to capture and monitor data about their students' non-cognitive skills—social and emotional skills not explicitly related to educational attainment but still important for student well-being and performance.[27] Non-cognitive skills include traits such as tenacity, motivation, self-efficacy, and resilience, and education policy experts have increasingly stressed the importance of these skills for preparing students for success in the 21st century economy.[28] Though these skills are much more challenging to measure than, say, a student's proficiency in calculus, educators still collect this data in more or less the same way, via standardized tests and surveys, or rely on anecdotal observations, both of which limit the accuracy and usefulness of the data.[29] It is difficult to develop a standardized test question that can reliably reveal a students' level of tenacity, for example, and surveys about students' social and emotional development are subject to the shortcomings of self-reporting, such as students' personal biases, exaggeration, and falsified answers.[30] However, student information systems that can collect more granular data and combine disparate datasets can provide much more useful insight into the development of these non-cognitive skills and promote more effective intervention.[31] For example, advanced testing software can assess non-cognitive skill development by combining a variety of survey methods that reduce the likelihood that students will falsify data, which is common in self-reporting, and automatically provide educators and parents with a comprehensive analysis of students' non-cognitive competencies.[32]

Better monitoring and providing access to student data is useful, but as education software companies develop new analytical techniques and more data populates student information systems, the true value of these systems will be their capacity to turn data into actionable insight. For example, at the college level, many schools are experimenting with predictive analytics systems that can flag students at high risk of failing or dropping out based on risk factors such as declining performance and regular absenteeism; this allows for early and effective intervention.[33] Using a similar approach, the Tacoma, Washington public school district applied predictive analytics to data from its student information systems to develop intervention strategies that increased its high school graduation rate from 55 percent in 2010 to 82.6 percent in 2016.[34]

LEARNING MANAGEMENT SYSTEMS

Learning management systems, sometimes called instructional management systems, are digital tools that help educators deliver instructional content and analyze student performance, as well as better understand the relationship between student learning, attainment, and teaching.[35]

Simple learning management systems consist of technologies such as educational software, online educational content, digital assessments,

and other tools that essentially serve to replace traditional pen-and-paper methods.[36] Even these simple systems can help educators make more informed decisions about instruction that can increase teacher effectiveness and student attainment. For example, at the beginning of the school year, a math teacher could use assessment software to establish an incoming class of students' baseline knowledge about different subject matter and use this data to restructure the curriculum. This data might reveal that most of the class is more proficient than expected with mathematical functions and graphs, but is less knowledgeable about derivatives, allowing the teacher to tailor the curriculum accordingly.

With more robust tools, learning management systems can capture considerably more useful data. Embedded assessment tools, for example, can capture data on student proficiency in real time as students take a test, providing educators with a much higher level of insight into a student's ability than traditional testing could offer.[37] An online homework application that reports data about how long a student spends on certain categories of problems over a week can reveal much more about how that student is progressing than just whether or not he or she gets the right answers. If a whole class were to use this application, a teacher could quickly learn if he or she should spend more time reviewing certain content or learn if particular students are struggling and provide them extra help. With such detailed data about individual student progress, teachers can spend more of their time teaching rather than testing. For example, assessment tools developed by education software company Lexia automatically inform teachers about individual students' skill levels and rates of progress and generate action plans tailored to address the weakness of individual students at risk of not reaching specific goals.[38]As learning-management systems mature and integrate with student information systems, they can serve as powerful decision-support systems to provide educators with detailed, timely data about how individual students learn combined with specific, actionable recommendations to increase student achievement.

Learning management systems can also include adaptive learning technology–instructional software that automatically adjusts how it delivers content, such as by increasing the difficulty of questions, providing additional example problems, or explaining certain concepts more thoroughly, based on its analysis of student performance.[39] Adaptive learning technology is still nascent, but a number of EdTech companies, including McGraw-Hill Education and Pearson, already offer adaptive learning features in their products.[40] Eventually, learning management systems will likely also take advantage of machine learning to both assess students and help teachers make better decisions. For example, IBM is developing a learning management system called "Watson Master Teacher" with its Watson cognitive computing system that is already in use in clinical decision-support systems; it promises to

improve patient outcomes by providing doctors and nurses with timely, patient-specific data to help inform important choices like medication dosage, relevant medical literature and research, treatment options, risks of harmful drug interactions or side effects, and so on.[41] Watson Master Teacher would provide teachers with timely, student-specific recommendations informed by educational research and historical data that no teacher could possibly arrive at independently.[42]

DATA WAREHOUSES

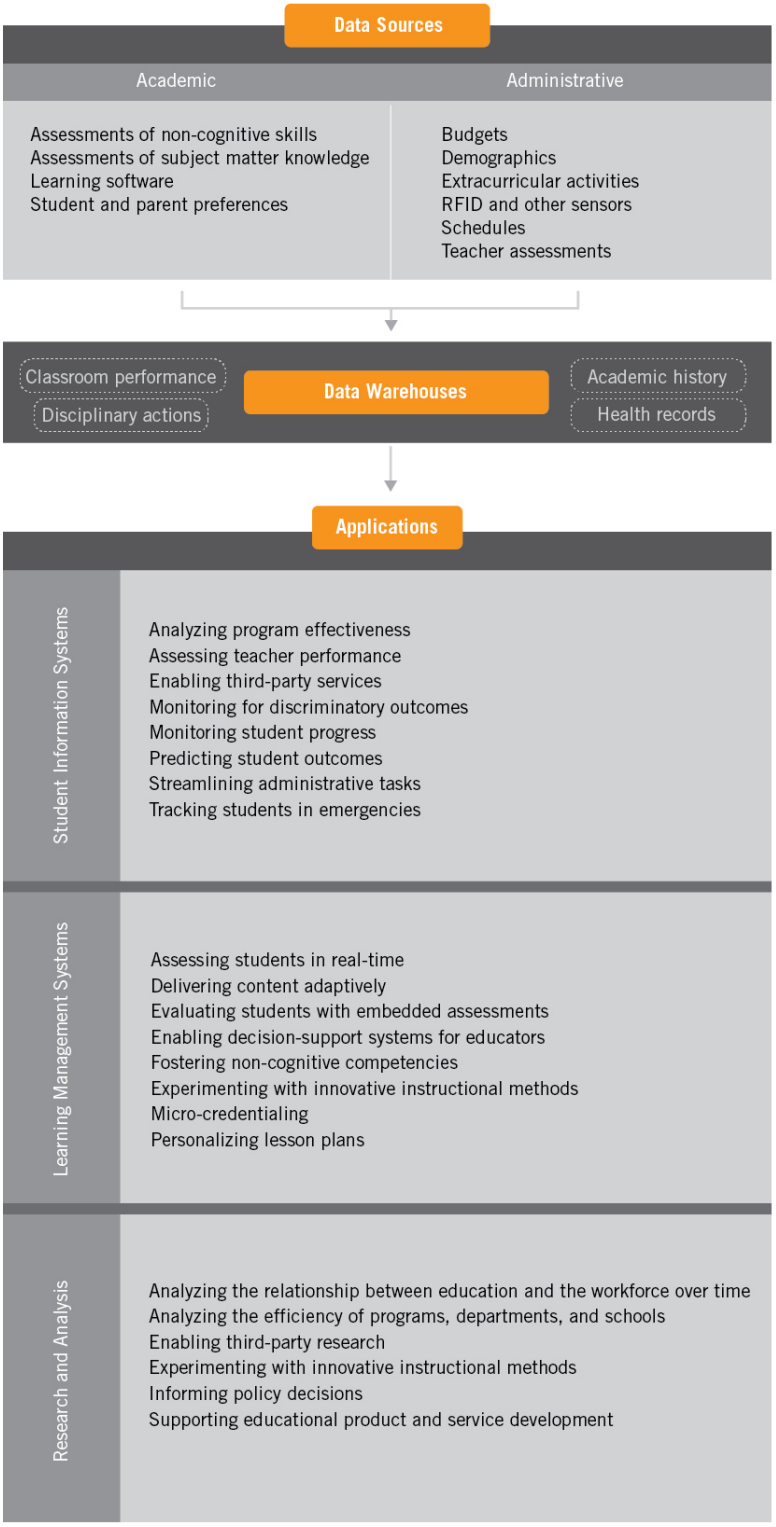
Databases serve as the underlying infrastructure for data-driven education by housing all of the data from student information systems, learning management systems, and other resources, such as administrative records.[43] However, simply having a standard database designed to support data storage and retrieval is not enough to make data-driven education a reality.[44] Rather, data warehouses, which are specialized systems designed to facilitate analysis by aggregating multiple data sources, are the foundation of data-driven education, as they enable policymakers, administrators, and researchers to link and analyze data across the education system.[45]

The most substantial education data warehouses in use are the Statewide Longitudinal Data Systems (SLDS)–large scale, comprehensive data warehouses built with federal grants that help states manage and analyze their education data. Since 2005, 47 states, as well as the District of Columbia, Puerto Rico, and the Virgin Islands, have received federal funding to build their SLDS, which help states manage and analyze education data.[46] For each round of federal SLDS grant funding, which awards participating states up to $20 million each over a period of three to five years, the Department of Education has set progressively higher standards for SLDS to improve the usefulness of the data and create a fully longitudinal student record, linking data from early childhood education, K-12 education, and the workforce, known as P-20w information.[47] Statewide Longitudinal Data Systems, if designed and implemented properly, offer enormous research potential, as they create a comprehensive view of the entire education landscape. For example, a fully linked P-20w SLDS enables researchers to track the effects of different types of pre-K education on starting salary, or allows administrators to analyze the effectiveness of a particular textbook and curriculum on standardized testing averages. And, nationally uniform SLDS data collection and linkage requirements would allow for researchers to track granular student records throughout the entire education system over time and perform comprehensive, large-scale analysis, as well as allow school administrators to more easily exchange student data when students move between schools and across state lines.[48]

Data warehouses can also enable more direct benefits at the school district level. For example, school administrators could analyze data

about a group of students that performed poorly in a given year by pulling attendance records, test scores, course schedules, and extracurricular activities. Analysis of this data could, for example, reveal that all of these students played football for a new coach who did not give the students enough time to study. District-level data warehouses also make it easier to share detailed insights with third parties to better support students. Metro Nashville Public Schools, for example, uses its education data warehouse to share with local police information about where students live; thus administrators can better understand the safety risks some of its students face based on their neighborhood, as well as share information with a local network of after-school care providers to understand what after-school programs are effective for students in high-risk areas and how to increase participation.[49]

Figure 1: The Building Blocks of Data-Driven Education



GOALS OF DATA-DRIVEN EDUCATION

An education system that comprehensively restructures its operations around data can achieve four major goals that are beyond the reach of an education system that just uses technology to augment standard procedures. These are: evidence-based learning, in which decisions about instruction are solidly grounded in data; personalization, in which the education system dynamically adjusts to the unique needs of every student; school efficiency, in which administrative decisions are clearly and strongly aligned with increased performance; and unlocking innovation, by providing stakeholders access to useful and useable education data that can serve as a powerful platform for innovation.

PERSONALIZATION

Personalized education is customized, dynamic, and tailored to the abilities, interests and needs of a particular student based on that student's data and informed by historical data.[50]

In a personalized educational environment, educators can design learning experiences based on data indicating what kinds of approaches would be most effective for particular students. For example, teachers could tailor instruction to be more personally relevant and engaging for students, but still adhere to a common rubric to assess progress.[51] Adaptive learning technology can analyze students' longitudinal records and monitor individual student performance in real time and dynamically adjust content, such as by lowering or raising complexity, to help students progress as quickly as possible based on their individual strengths and weaknesses.[52]

Some of the most significant benefits of personalization stem from data-driven improvements to student assessment. The education system relies on two main types of assessment: Summative assessments measure student competency at major intervals, such as at final exams or after standardized testing; and formative assessment relies on smaller, embedded checks for understanding such factors as completion of homework, projects, and class participation. The information provided can shape the ongoing instructional process.[53] Summative assessment can be useful for measuring the effectiveness of a program, but it can be disruptive and only provides feedback well after instruction occurs, limiting educators' ability to apply this data in useful ways.[54] In a personalized education environment, robust learning management systems can allow for much greater reliance on formative assessment as they can capture and apply much more granular data about a student's competencies in real time and prompt a change in instructional approach as soon as it could be beneficial.[55] This formative assessment data could also be used to create real-time dashboards on student performance in student information systems that allow parents to be more informed about their child's progress and needs, allow students to

be more cognizant of their own performance, and allow teachers to improve their own practices and the practices of others.[56] This would be a far cry better than the quarterly report cards that provide parents and students with a simple letter grade for each subject.

With frequent embedded, formative assessment in personalized learning management systems, educators can also implement more varied curricula, while still spot checking to ensure all students meet certain common standards for various proficiencies. One particularly promising method of implementing this approach is through the use of micro-credentialing, sometimes called badges.[57] Rather than evaluate student competency at time-based intervals, learning management systems can award students micro-credentials that represent mastery of a specific skill as soon as students achieve it. [58] For example, students can earn badges for successfully mastering a particular type of math problem and then move on to the next type, rather than having to study large chunks of the curriculum all at once and demonstrate their proficiency at the end of a unit. Micro-credentials also make data on student attainment much more portable, allowing other educators to easily understand a new student's abilities and to tailor instruction accordingly, and badges can also serve as metadata in educational datasets to increase the research value of longitudinal student records.[59]

With personalized learning and assessment, the education system as a whole could shift from a time-based approach, in which students are required to learn and demonstrate a particular set of competencies every year, to a competency-based approach, in which a student can fulfill an assessment when data indicate that their competence is sufficient, rather than be tied to a calendar date.[60] A benefit of the traditional, time-based approach is that it aligns the development of non-cognitive competencies, such as social and emotional development with educational attainment. However, as new data technologies create new opportunities to measure and foster non-cognitive competencies, the need to rely on a time-based approach will lessen even further.

And, deployed at scale, personalized approaches would have a transformative effect on the entire education system. Individual attainment would not be limited by class structures that require teachers to "teach to the middle" to accommodate the varied needs and proficiencies of dozens of students simultaneously.[61] High-achieving students could reach new heights, low-performing students could be brought up to speed faster, and all students could benefit from instructional techniques that work best for them while still striving to meet or demonstrating a common set of competencies.

EVIDENCE-BASED LEARNING

The goal of evidence-based learning is to enable educators quickly and easily to record, analyze, share, and apply data to inform every aspect of

their decision-making, rapidly learn from new information, and create communities of practice to facilitate the development and dissemination of effective methods.

With robust student information systems that capture a wide variety of granular data about the classroom experience, teachers can make substantially more informed decisions with little extra effort. Well-designed data warehouses designed for easy access to and sharing of complex data can enable educators to easily access data about particular educational challenges from other, similar school districts and classroom settings and to study and replicate practices that led to successful outcomes. Teachers and administrators can compare models from the latest educational research with the longitudinal records of their own students to see if certain intervention or educational programs would increase student performance. Teacher success would no longer be limited by a static level of training, as teachers and researchers share information about new and effective practices.

Importantly, a constantly growing evidence base for educational decisions and easy access to this evidence would have a democratizing effect on educational expertise. Schools that lack resources or sufficiently trained teachers would be able to meet the needs of their students more effectively by applying strategies developed and shared by schools that have already identified better solutions to similar challenges.

Widespread implementation of evidence-based learning would also give rise to an education model analogous to the ideal model of health-care delivery known as a "rapid-learning network," in which health-care practitioners can seamlessly and quickly learn from new data, and disseminate information about best practices, new findings, and solutions to patient-specific challenges through data sharing and analysis.[62]

Overall, evidence-based learning would create a positive feedback loop for improving the education system: educators can more quickly identify problems, test solutions, and share data about outcomes, allowing other educators to build off this experience, develop best practices, and tackle other problems.

SCHOOL EFFICIENCY

With more and more data collected at every stage of the education process, schools have an unprecedented opportunity to measure the relationship between teacher and administrator actions and student outcomes, and then to allocate resources to better align educator practices with desirable outcomes. Additionally, with better data to assess program performance, schools can determine the most optimal way to allocate funding, prioritizing programs based on where additional

funding is most likely to increase performance and eliminating wasteful or inefficient spending.

On the classroom level, previous attempts to use standardized testing as the metric for improving education have largely failed because large summative assessments are a poor method of understanding the complex factors involved in determining whether or not certain teachers or actions are effective, particularly in low-income schools that have scant resources to operate effectively to begin with.[63] With robust data technologies that can more precisely measure student performance and instructional decisions, it becomes much easier to establish a causal link between a teacher's action and a student's success. Teachers can use this data to spend more of their time and resources on effective teaching strategies.

On an administrative level, better and timely data on student performance can help administrators make better decisions about the cost effectiveness of particular programs and materials. For example, a math department head could trail two differently priced math textbooks, compare their impact on student attainment, and observe if a more expensive textbook increases student performance significantly enough to justify the additional cost. Additionally, better data on teachers' decisions can help administrators more easily identify and replicate the successful strategies of high-performing teachers, as well as identify problematic teachers. Similarly, administrators could adjust teacher compensation to better reflect willingness to adopt successful practices. And before administrators even hire a teacher, existing statistical techniques can be used to predict a candidate's expected impact on student performance, thus preventing bad teachers from being hired in the first place.[64] Just as baseball managers use sabermetrics, the analytical strategy of *Moneyball* fame, rather than conventional wisdom to evaluate players with statistical analysis, school administrators could empirically evaluate and compare potential hires and predict their success at teaching certain groups of students. Often, student test scores on large summative exams are the main data administrators have available to understand teacher performance, so teachers devote significant amounts of time "teaching to the test" to ensure that their students demonstrate a narrow, very particular set of competencies, rather than supporting more broadly defined student learning strategies. Instead, better methods to capture data on teacher effectiveness and the relationship between their actions and student performance, combined with the ability to rely on more embedded, formative assessments, can allow administrators to gain a much more nuanced understanding of teacher effectiveness. Finally, better data on how an entire school functions can help administrators observe the impact that administrative decisions, such as class scheduling, extracurricular activities, course offerings, and so on, have on a school's performance and adjust policies accordingly.

Learning management systems that take advantage of open source materials can also help schools cut costs without sacrificing quality. In September 2015, Education Secretary Arne Duncan challenged public schools to replace just one textbook with an openly licensed book for this very reason.[65] Educational materials with an open license can be continuously updated with new content so schools do not have to buy new sets of books every few years, leaving teachers free to tailor the content of these textbooks based on the strengths of individual students or classes as a whole, as well as their own expertise, to meet student needs more effectively.[66] This would particularly benefit low-income school districts that cannot afford traditional, licensed textbooks and increase access to high-quality educational resources for low-income students.

CONTINUOUS INNOVATION

A data-driven education system, in which it is easy to collect, store, analyze, use, and share data, will allow education data to serve as a valuable platform for innovation. Teachers, administrators, students, parents, policymakers, researchers, developers, civil society groups, and all other education stakeholders will have access to data with which they can build new tools and services, make better decisions, uncover new insights, create predicative models, and experiment in ways they never could before. And the benefits of these innovations will contribute to the improvement of the education system as a whole.

By publishing administrative and performance data as open data–freely available data in machine-readable and open formats–schools can provide parents, civic hackers, policymakers, and EdTech developers with valuable information that can promote transparency, accountability, and improvements in school operations. For example, by combining open data about a school's budget with aggregated data about student performance, a civic hacker could identify relationships between school funding decisions and student outcomes and share insights about where a school might be over- or under-funding various departments and programs.

Through the use of student data portals, schools can allow parents and students to export student data in an open format, which can fuel the development of new and valuable services in the private sector. For example, parents can share student data with a tutoring company to match their child with a tutor that can best meet his or her needs. SAT preparation companies could analyze data that reveals detailed information about students' current academic ability to offer personalized studying plans to help them score as highly as possible on the test. And companies could offer services that aid in the college application process by analyzing a student's detailed academic history to recommend schools and estimate his or her likelihood of getting accepted.

Interoperable education data collected at every stage of the education process also greatly improves the research potential of education data. With access to large amounts of fully linked and interoperable student records from SLDSs, state departments of education could greatly improve the level of insight into how funding decisions, different curricula, charter schools, or any other factor influence educational outcomes. By analyzing thousands of longitudinal student records, researchers could create detailed predictive models about how early childhood education, for example, will influence a student's future academic achievement. This could also enable a clinical trial-type approach to education, in which educators can experiment with different approaches to gauge their effectiveness. Anthony Bryk of the Carnegie Foundation for the Advancement of Teaching says that efforts to use a clinical trial model in education are not particularly effective because they only reveal whether or not a particular intervention worked, and not how to apply that intervention effectively to different populations.[67] But with detailed predictive models about student performance and much larger pools of student data to analyze, researchers could effectively simulate educational experiments based on initial trials to learn how to apply them at scale.[68]

Naturally, better data about every step of the education process would also be a tremendous boon to the EdTech industry. Schools can share anonymized student data with EdTech developers to develop new products and services. For example, a learning management system developer could monitor the impact of their dynamic assessment software on student achievement and regularly update its algorithms based on what it learns to be most effective. Data sharing agreements between schools and developers can provide developers with the education data necessary to develop and test their technologies while schools can benefit from the improved products and services that result.

THE IDEAL DATA-DRIVEN EDUCATION SYSTEM

If the education system can successfully leverage all of the building blocks to achieve the goals of data-driven education, it will look significantly different than it does today. Students could have personalized and dynamic lesson plans that address their individual strengths and weaknesses and interests rather than carry out the same exact work as their classmates of varying ability levels. Teachers could devote the majority of their time to delivering instructional material and ensuring student success, rather than lose valuable classroom time to administrative tasks, disruptive summative assessments, or helping bring certain students up to speed while others in the class are already comfortable with the material. School administrators could make much more informed decisions about how to allocate resources, ensure that students are treated equitably and take steps to address disparities, and better manage teachers. At home, parents could easily access their children's data to monitor their performance, stay more engaged in the

education process, and access a variety of additional educational resources that can make use of this data to provide better supplemental education. Researchers and EdTech developers could easily access large quantities of education data to develop new insights into education, develop and improve useful products and services, and help schools to improve their performance. And finally, policymakers at all levels would have a wealth of data with which they could make well-informed decisions about education policy. Overall, a data-driven education system would entail the large-scale collection, sharing, analysis, and use of granular education data by every education stakeholder.

OBSTACLES TO EFFECTIVE DATA-DRIVEN EDUCATION

Unfortunately, the United States has made little progress towards data-driven education due to considerable cultural, political, technological, and administrative barriers. In fact, there are at least seven major obstacles to building a data-driven education system, including institutional resistance, hostility to using data in the classroom, a lack of effective tools, inadequate teacher training, flawed data infrastructure, systemic "chicken or egg" challenges, and, perhaps most significantly, privacy fears.

TEACHER RESISTANCE

Data-driven pedagogy is fundamentally different from traditional approaches in that it is goal-oriented rather than process-oriented. Educators evaluate and adjust practices based on their direct impact on learning, rather than emphasizing certain processes and delivery in the classroom.[69] This approach can directly challenge educators' notions of what they believe to be effective, which means it can face resistance from even well-meaning teachers who believe reliance on evidence-based practices perhaps reduces their autonomy, who do not feel data reflects their real-world experiences, or who are concerned that data will be used to punish them, rather than promote student success.[70] These concerns are not necessarily unwarranted, as data-driven teacher assessments, for example, have been executed poorly in the past, relying on arbitrary or unreliable metrics to determine a teacher's compensation or continued employment.[71] However, previous missteps do not justify staunch opposition to data-driven education, which if implemented correctly, would benefit all students and most teachers.

Due to other obstacles detailed below, it is likely that this institutional resistance will remain entrenched for years to come as educators have little incentive to embrace change, and because schools do not have to compete by embracing innovation like businesses do to avoid losing customers.

HOSTILITY TO USING DATA IN THE CLASSROOM

Data-driven decision-making in education is highly associated with the controversial No Child Left Behind Act (NCLB), as its data-driven components focused on accountability to the federal government, tying funding to performance metrics, rather than focusing explicitly on improving learning.[72] As a result, the problematic legacy of NCLB, such as increased pressure to "teach to the test," have cultivated a strong aversion to using data to drive decision-making in the classroom.[73] Using data to hold teachers accountable for their performance, without also using data to help teachers improve their performance, is shortsighted, and has also fueled a general resistance to standardizing certain aspects of education, such as Common Core.[74] This is undesirable because learning management systems will need to be able to break down education into certain standardized pieces to effectively customize instruction and assess whether students are progressing at an ideal pace.

LACK OF EFFECTIVE TOOLS

According to a 2014 survey of 4,600 teachers by the Bill and Melinda Gates Foundation, a majority of teachers believe data could improve their teaching, but 67 percent of teachers feel that they do not have the tools to use data effectively.[75] Furthermore, teachers feel that the data they do have are not sufficient to improve instruction due to a variety of shortcomings of these tools; in particular, they do not provide easy access to useable, detailed data.[76] In short, even when teachers want to improve the education system through the use of data, they cannot. This obstacle may actually reinforce the institutional and general resistance to using data in the classroom, as the shortcomings of poorly implemented and ineffective data tools may cement the notion that pursuing data-driven education is not a worthwhile endeavor.

The shortcomings of the data tools available to educators is likely compounded by the lack of a consolidated, "single solution" system for all of a school's data needs.[77] A 2010 report from the Department of Education found that most school districts rely on between three and seven distinct data systems to help support instruction.[78] In theory, the number of systems is irrelevant as long as they can freely exchange data with one another and meet all of education stakeholders' needs. However, also according to the Department of Education, 60 percent of districts noted that their systems were not interoperable, thus limiting their ability to expand the use of data in the classroom.[79]

INADEQUATE TEACHER TRAINING

Educators are simply not trained to transition to a data-driven pedagogy. Teachers and administrative staff would require substantial additional support to learn how to leverage data effectively, and educators are already in dire need of data literacy training.[80] As of February 2014,

only 19 states included demonstration of data literacy skills, such as the ability to evaluate the accuracy of a dataset and the ability to transform data into actionable insight, as a requirement for teacher licensure.[81] Not all teachers need to be full-fledged data scientists of course, but they need to be skilled enough so that using data is a natural and seamless part of the teaching process, and not a burdensome secondary process.

FLAWED DATA INFRASTRUCTURE

The infrastructure necessary to support effective data-driven education is also severely flawed. Though complete linkage of P-20w data is the stated goal of the federal SLDS grant program, only 19 states fully linked this data as of 2014, instead only linking early childhood data with K-12 data or only K-12 data with workforce data.[82] When these systems do not effectively link all of these categories of data, the insight an SLDS can provide is necessarily limited, and with such large inconsistencies from state to state, there is no reliable way to analyze diverse, de-identified student records over time to observe trends in education. Furthermore, regardless of how well this infrastructure is designed, educators need to be able to easily access this information, yet only 13 states have policies to ensure that teachers can access their student's longitudinal data.[83] And, only 22 states automatically share teacher performance data with state-educator training programs on at least an annual basis. [84]

Other types of education data systems do not always prioritize interoperability, effectively turning education databases into data silos. In 2010, 60 percent of school districts reported that a lack of interoperability across data systems limited their ability to take advantage of data-driven decision making.[85] Non-interoperable systems reduce the ability of stakeholders to use data effectively as well as limit a district's capacity to implement new and better EdTech.

SYSTEMIC "CHICKEN OR EGG" CHALLENGES

The structure of the education system itself presents challenges to the advancement of data-driven education. The development of robust, effective, interoperable data systems depends on school districts' broad adoption of these systems. However, school districts are limited in their ability and willingness to adopt these systems because thus far, these systems have been limited in their effectiveness, schools have little incentive to disrupt their operations, and cultural and political pressure prevents schools from expanding their collection and use of data. This problem is compounded by the fact that while many such systems can offer greater benefits with greater adoption, the nature of the education system—distributed networks of school districts with widely varying standards, budgets, technical ability, and differing state laws about data collection and use—limits productive efforts to coordinate adoption. For

example, a learning management system that offers predictive insights into student performance can generate better and more personalized recommendations if it can analyze a larger pool of historical education data of students with similar profiles. However, hundreds of different school districts simply do not coordinate with each other to ensure they are purchasing interoperable systems.

PRIVACY FEARS

Though many parents are supportive of educators using student data to improve instruction, efforts to do so are almost invariably met with a strong backlash from some parents wary of the potential misuse of student data.[86] EdTech plays a crucial role in data-driven education, and as public school districts are not, nor should they be, in the business of software development, the private sector is the main driver of EdTech innovation.[87] Building and operating EdTech necessarily means using data from the classroom, yet according to a survey from the Future of Privacy Forum, 58 percent of parents are not comfortable with private companies accessing student data.[88] This translates into powerful advocacy efforts to thwart innovative new EdTech and efforts to use data to improve education. For example, in 2013, fierce backlash from parents caused school districts to end their partnerships with inBloom, a nonprofit organization focusing on improving how schools manage and use student data, due to overblown, and ultimately false, concerns that inBloom would sell student data to the private sector.[89]

Parents' desire to ensure that student data is used and managed responsibly is understandable, but this frequently translates into undesirable and uninformed efforts that sabotage the potential for improving education through data. According to the same Future of Privacy Forum survey, only one in five parents understand how federal laws restrict how schools and companies can use student data and protect student privacy.[90] Approximately the same proportion are aware that such laws exist, but do not know the restrictions they impose.[91] And approximately 50 percent of parents do not know anything about federal laws that restrict how student data can be used. And yet, 57 percent of parents support the creation of new laws to address concerns about the responsible handling of student data.[92] This means that a significant portion of support for restrictive privacy measures is necessarily misinformed, and thus policies that use this support as justification are necessarily misguided.

In some cases, parents resist, and support advocacy efforts to resist, data-driven efforts to improve education out of concern that granular data about their children's entire educational history could create "reputational damage" that hurt their children's future prospects.[93] These parents worry that if, for example, their daughter struggled in history for several years before bringing up her grades, college admissions and even employers might access this data and use it

against her. However, the solution to this concern is more data, not less. An admissions counselor reviewing a high school transcript only has a handful of data points to inform his or her decision, such as summative assessment results. With more granular data about a student's entire educational history, a few years of bad grades would be placed in much clearer context, and there would be potentially even more data showing how he or she improved over time. And for more extreme fears, for example that employers might discriminate against job applicants because of their income level or because English is their second language or because they have a learning disability, existing antidiscrimination laws would protect against such practices.[94]

Privacy fears in particular are often leveraged by groups with other motivations than simply protecting privacy and ensuring the wellbeing of students.[95] For example, efforts to improve education data infrastructure, particularly SLDSs, are hampered by privacy fears propagated by groups worried about ceding state purview over the education system.[96] Many of the problems with SLDSs, such as a lack of interoperability and incomplete P-20w linkage, could be easily remedied by a centralized approach. However, citing concerns about student privacy and the security of a centralized system, the 2008 reauthorization of the Higher Education Act explicitly forbade the creation of a federal database for student records. Such concerns are misplaced, as the same protections on how student data is managed and used could apply just as easily to a centralized federal data warehouse rather than 50 separate ones. While a centralized longitudinal data system is not inherently better than 50 fully linked and interoperable SLDSs, unfounded concerns about centralization are responsible for the widely varied, non-interoperable SLDSs environment today. This has sacrificed a valuable opportunity to gain unprecedented insight into the relationships between K-12 education and college and workplace outcomes.[97] And since networked technologies increase in value as they increase in size, an interoperable network of 50 SLDS could prove to be dramatically more useful than 50 separate and poorly managed ones.

Sometimes, fear is used as a tool by groups that benefit from opaque, inefficient, and unaccountable education system and want to quash data-driven improvements. In May 2015, Connecticut's largest teacher's union accused the Hamden school district of irresponsibly sharing student data with the Connected Council for Education Reform (CCER), a nonprofit research group devoted to reducing achievement gaps between poor and wealthy school districts.[98] The union called for legislation to prevent the school district from doing so, arguing the data could be personally identifiable and used to harm students.[99] However, CCER was using the data to identify opportunities to improve administrative efficiency, none of the data could have personally identified students, and CCER was not selling the data.[100] Since CCER's

analysis could have resulted in the school district firing ineffective teachers, it is likely that this opposition was motivated more by fear that CCER's analysis would result in eliminating redundant or ineffective personnel, than by concern for student's wellbeing.

In other cases, privacy fears are simply born out of fear of technology. In California for example, after Brittan Elementary School implemented RFID in student identification cards to track attendance, policymakers repeatedly attempted to ban the use of RFID to track students, citing concerns that it could somehow violate student privacy.[101] Privacy advocates were quick to stoke these fears while also alleging that use of RFID in schools robbed students of their dignity by "treating them like cattle or pieces of inventory," alluding to the wide and varied use of RFID in other sectors.[102] In reality, Brittan Elementary relied on RFID simply to save teachers time by making it easier to take attendance, yet the fierce backlash from privacy advocates caused the school to cancel the program after just two weeks.[103]

Notably, those warning about privacy fears often do not consider, or perhaps outright dismiss, the potential for student data to be effectively de-identified. No parent should be concerned about schools sharing student data when that data can be stripped of any sensitive, identifiable information. Despite some public hand-wringing about the reliability of de-identification, when done properly, de-identification is an effective method for responsibly sharing sensitive data.[104]

POLICY RECOMMENDATIONS

Federal and state policymakers, as well as education officials at the local level, should take a series of steps to accelerate the development of a data-driven education system.

ENCOURAGE SMARTER DATA COLLECTION AND MANAGEMENT

The cornerstone of data-driven education is data, and thus generating and managing this data properly throughout its entire lifecycle—collection, storage, management, transfer, and application—should be a top priority for all education stakeholders.

At the beginning of the education data lifecycle, policymakers, teachers, and administrators should reevaluate data collection practices to encourage effective data use. First and foremost, educators should ensure that all data collection relies on digital formats, rather than paper, as paper-based data collection is dramatically less useful–manual recording or copying can be error prone and time consuming, data recorded on paper is not easily accessible or transferable, and it can be easily lost or destroyed. Second, improving data collection should entail shifting away from a compliance-based reporting approach. Most state education data-reporting efforts focus on compliance with state and federal laws, rather than solving educators' problems and answering

education stakeholders' questions.[105] Reporting requirements for schools necessarily influence what and how educators collect and manage data, so federal and state policymakers should ensure that reporting requirements are aligned with the information needs of education stakeholders.[106]

Additionally, states should ensure they stay abreast of advancements in EdTech that enable the collection or application of new kinds of useful data. As new tools make it possible to collect more granular data about student learning both inside and outside the classroom, such as through online homework platforms that record how long it takes for students to complete different types of problems, it should be easy for educators and administrators to implement these new data streams into student information systems and learning management systems.

Policymakers should avoid restricting the collection of education data that has valid, beneficial uses. For example, Oklahoma allows parents to opt out of data collection efforts that would contribute their children's data to the state's SLDS, except for a bare minimum student record.[107] Not only does this have the potential to substantially limit the value of the SLDS, but all students benefit from the research potential and insights that SLDSs can provide, so allowing parents to opt out creates a "tragedy of the commons" for the education system—parents want to reap the benefits of a system without making even benign contributions. In Florida, legislation prohibits schools from collecting any kind of biometric data, effectively banning a wide variety of EdTech that could make use of eye tracking, fingerprint scans, or other biometric data.[108] For example, online learning tools could use eye tracking software to measure student engagement and use this data to improve how it presents content. And in Georgia, student data cannot be collected to develop commercial products or services, no matter how anonymized or aggregated the data would be, greatly reducing the potential for the private sector to develop innovative EdTech.[109] Where these unnecessary restrictions exist, policymakers should eliminate them, and when they appear in future student data protection proposals, policymakers should strike them.

ENCOURAGE DATA SYSTEM INTEROPERABILITY

Policymakers should also strive to make education data as accessible and usable as possible to all stakeholders. Importantly, state policymakers should require school districts' use of the Common Education Data Standards (CEDS), common standards developed by the Department of Education for P-20w institutions education data to ensure that they can implement EdTech that allows them to easily share data with one another, with districts in other states, with the federal government, with researchers, with nonprofits, and with the private sector. [110] For all future SLDS funding, the Department of Education should require adoption of CEDS, but to achieve widespread use, all

states must decide to adopt the standard themselves. [111] Mandating CEDS usage would not limit the ability of school districts and EdTech developers to work together, but instead help schools and districts more easily navigate the EdTech market and ensure that EdTech vendors develop interoperable tools that any school can integrate into their education data systems. For example, the EdTech organization Ed-Fi Alliance builds education data tools based on CEDS specifications; and the School Interoperability Framework (SIF), a nonprofit membership organization of public and private-sector institutions, sets vendor-neutral, platform-independent protocols for EdTech structured around CEDS. [112] However, SIF implementation can vary dramatically between and within states–Massachusetts has mandated all EdTech vendors to be SIF certified, while only one school district in Arizona utilizes SIF-compliant technology.[113] Interoperable data systems are essential for making data easily portable within a district, between schools, across state lines, and with developers and researchers.

Additionally, for all future SLDS grant, Congress should stipulate that funding be used to fully link P-20w data. Thus far, only 19 states have successfully linked all of their education data and there is no reason for the SLDS grant program not to more aggressively pursue its state goal of complete P-20w linkage for all SLDSs.[114]

EMPOWER STUDENTS AND PARENTS WITH ACCESS TO THEIR DATA

Beyond improving data accessibility and usability within schools, school districts should also set high standards for parent and student data access and use. This entails stipulating that student information systems are user-friendly and contain timely and useful data, as well as providing educational resources for parents and students about how to use these systems. Not only does this increase student performance and promote student and parent engagement, but familiarizing parents with the beneficial applications of education data would help to alleviate some of their apprehension about student data collection.[115]

State and federal policymakers should also focus on making students' education data as portable as possible. Just as patients can transfer their electronic health records between doctors, parents should be able to easily transfer their children's student records when they change schools. Fully linked and interoperable SLDSs would advance this goal, but state policymakers should also ensure that student data portals allow parents to easily export student data. Unfortunately, prior federal efforts to make student data more portable have made little progress. In 2012, the Department of Education announced it was working with major EdTech vendors to develop a "MyData" button that would allow students to download all of their data at the click of a button, yet no such button has been created.[116] There are many likely reasons for this, such as the Department of Education's inability to coalesce complete student records from states with a wide range of different, non-

interoperable EdTech systems and poorly linked SLDSs, but this is still a worthy goal. As the education data lifecycle improves for the education system as a whole, the Department of Education should work with EdTech vendors and state departments of education to again pursue the development of the MyData button. Not only would the MyData button make it substantially easier for students and parents to access their own data, but having this data in a machine-readable, single package would encourage the development of innovative new student-facing tools that can use this data.

Finally, federal and state policymakers should support school district efforts to publish education data as open data. Properly de-identified and aggregated, open data about school performance, such as administrative spending, class size, and student achievement, can allow stakeholders to easily scrutinize budgets, hold administrators accountable for wasteful spending, identify opportunities to improve school efficiency, and develop tools to promote parent engagement. Despite the likely resistance from parents and teachers skittish about education data, and groups that benefit from opaque or inefficient school practices that will raise privacy concerns to limit the publication of this data, administrators should recognize that they can effectively and reliably de-identify data.[117] Furthermore, requiring school districts to treat their data as open by default would promote better data management practices at every stage of the data lifecycle, which would have the added benefits of greater school efficiency and more effective data use.

PROMOTE DATA-DRIVEN DECISION-MAKING

Policymakers' first priority should be to accelerate the development and implementation of the building blocks of data-driven education, including an effective education data lifecycle. Thus, in some cases, it may not make sense to prescribe specific policies to support data-driven decision-making through the use of these building blocks until they are fully in place, as specific best practices remain to be identified. There are nonetheless several opportunities for policymakers to promote data-driven decision-making now.

Most significantly, as new EdTech makes its way into the classroom and new opportunities to collect and use data arise, policymakers should ensure that educators are able to use this data to make better decisions. State and federal education funding for EdTech should also prioritize training for that technology, as giving teachers the best data tools in the world would do little to improve education if the teachers do not know how to use those tools. Beyond ensuring educators can use EdTech effectively, policymakers should also promote data literacy more generally for teachers and administrators. While teachers of course do not need to be data scientists, they should be comfortable handling classroom data and using it to solve problems. Thus far, only 19 states

have adopted data literacy components in their educator licensure requirements.[118] On the state level, policymakers should ensure that educator licensure requires demonstration of data literacy skills and regular educator performance evaluation should require demonstration of these skills. Ongoing professional development programs should also focus on using data to improve decision-making.[119] States should also incentivize school districts to use data, such as by encouraging more flexible teacher scheduling to allow for data-focused professional development courses in addition to offering more intensive courses during the summer.[120] And on the federal level, policymakers should leverage grant funding to incentivize data literacy programs, and the Department of Education should provide guidance for educators on effective data use.[121]

Relatedly, policymakers at the state and federal level should make it as easy as possible for educators across the country to share data with one another. Just as cancer patients benefit when doctors can review the health records of similar patients to identify potential effective treatments, students stand to benefit when teachers can share information about similar students to make their instruction as effective as possible.

States should also regularly evaluate standardized testing policies to identify opportunities to adopt data-driven assessment technologies that can make better use of data from embedded, formative assessments and support spot-checking individual performance, transitioning away from large and disruptive summative assessments. This may require states to rethink how they standardize their curricula, as greater reliance on formative assessments and practices such as micro-credentialing can enable more engaging, varied learning paths and encourage an attainment-based, rather than time-based, approach to student progression.

Finally, school districts, states, and the federal government should eliminate barriers to public-private partnerships that can promote effective data use. This could entail revising a school district's data-sharing policy so that nonprofits or other groups with education expertise can analyze school performance data and identify opportunities for improvement. Alternatively, this could also mean making it easier for states to responsibly share education data with private-sector EdTech developers to accelerate the development of innovative data technologies.

DO NOT GIVE IN TO PRIVACY FEARS

Increased collection and use of classroom data, particularly by private-sector EdTech developers, will continue to stoke fears of abuse of student data that threatens to slow the progress of data-driven education. For example, a new initiative to share school data with

researchers may prompt advocacy groups who pay little attention to the benefits of the initiative to lobby policymakers to dismantle the program. Alternatively, policymakers and educators themselves, fearing potential backlash for taking on data-related education projects may avoid pursuing these projects altogether. Policymakers and educators can take several steps to counter these fears.

First, policymakers at all levels and educators should highlight the value of data in education and stress the necessity of collecting, sharing, and analyzing this data for any of this value to be realized. According to a survey of public and charter school parents, 89 percent are fine with school personnel accessing student data, but a significantly smaller percentage think third parties should be able to do so; 63 percent are comfortable sharing student data with researchers; 42 percent are comfortable sharing student data with companies developing EdTech; and just 34 percent are comfortable giving nonprofits access to student records.[122] This suggests a clear lack of understanding about "how the sausage is made"—developing innovative data-driven solutions for education and taking advantage of advanced EdTech necessarily means sharing education data with third parties that can put this data to good use. In addition to raising awareness about education data generally, policymakers and educators should also actively engage with parent advocacy groups and firmly rebuke alarmist concerns when they arise. And when possible, policymakers should encourage EdTech developers to be as forthcoming as possible with information about how they use data and to demonstrate their responsible protections for student data.

Importantly, when faced with harmfully restrictive proposals limiting how student data can be collected and used, policymakers should stress the many protections already afforded to student data by existing laws. For most of the common concerns about how third parties will use student data, there are likely already laws addressing these concerns on the federal level alone, in addition to many state laws. The Family Educational Rights and Privacy Act (FERPA) dictates that schools can only share data with third parties for legitimate educational purposes, such as with another school when a student transfers or with officials for auditing purposes, and it requires parental consent for other purposes.[123] The Protection of Pupil Rights Amendment (PPRA) requires explicit parental consent for data collection related to sensitive topics such as religious affiliation, as well as requires that schools provide parents with notification and an opt-out mechanism for data collection for marketing purposes.[124] The Children's Online Privacy Protection Rule (COPPA) provides a range of restrictions for third parties related to online data collection that could be used for marketing purposes, including requiring explicit parental consent for collecting any personal data.[125] Furthermore, policymakers should recognize that there are effective data-sharing models that allow schools to share education data while fully protecting student privacy, and encourage states to adopt

these models rather than implement new restrictions to data use. For example, the Department of Education has published a guide to education data-sharing that explains how to share education data to improve student outcomes while fully protecting student privacy.[126]

In general, when rules about student data collection and sharing are needed, policymakers should adopt opt-out approaches, rather than opt-in, to provide parents with control over their children's data. By providing adequate notice, parents are free to take steps to govern how their children's data is used, and by adopting an opt-out consent approach, schools are not overly burdened with administrative costs every time they want to do something new with data. However, this does not mean parents should be able to freely opt out of everything, as the success of data-driven education hinges on large-scale participation. A parent's right to protect the privacy of their child must be balanced with the education system's need to collect, use, and share a large variety of student data to benefit students as best as possible.[127] Policymakers should carefully consider the net benefits to the education system new data-driven initiatives can offer, and ensure that the success of the system as a whole is not diminished by overly cautious parents hesitant about sharing their children's data.

DEVELOP A MODEL DATA-DRIVEN SCHOOL DISTRICT

As there are no examples of a truly data-driven education system, the U.S. Department of Education should launch a challenge to establish a multi- year, fully data-driven school system pilot that can serve as a model for educators around the country. To be sure, some school districts have made significant progress towards becoming more data-driven, meaning a pilot program will not necessarily have to attempt to build a data-driven district from the ground up. For example, Montgomery County Public Schools in Maryland has invested heavily in data-driven approaches to education and made considerable improvements to student outcomes and reductions in achievement gaps.[128] A model school district pilot should focus on building on the momentum of this kind of initial success.

The Department of Education, in coordination with researchers, educators, and EdTech developers, should develop criteria for the challenge that participating school districts will have to meet, and provide implementation funding for the district that develops the best plan to do so. In addition to funding, the Department of Education should partner with leading EdTech developers ensure the winning school district can take advantage of the latest in education data technologies. To participate in the challenge, school districts should commit to making de-identified education data collected in the pilot available to researchers, to making student data easily exportable, and to sharing information about their successes and failures with other school districts that wish to adopt data-driven approaches. Additionally,

the district should be required to identify areas where state or federal restrictions on data collection and use limit its ability to effectively use data to improve education. Finally, the pilot should require that the winning district prioritize projects that can be easily replicated by other school districts after the pilot's completion, rather than projects that only meet the needs of that specific district.

Because of the network effects of many data technologies and because of the inherent limitations of certain states' SLDSs, this pilot will not establish a miniature data-driven education system in its truest sense, however it will break valuable ground by demonstrating to parents, educators, and policymakers that data-driven education is worth pursuing.

USE DATA TO PROMOTE EQUITY IN EDUCATION

As data technologies proliferate, more and better data about every part of the education system will make it easier than ever before for policymakers and educators to ensure the education system serves everybody equally.

Federal and state lawmakers should ensure that EdTech funding targets schools in low-income districts to develop a robust capacity to collect and apply data. While government funding should of course promote adoption of data technologies by the education system as a whole, having a particular focus on low-income schools will ensure that the lowest-performing schools can get the help they need and not be proportionately left behind as wealthier schools take more and more advantage of data.

As policymakers make it easier for school systems to share data with one another in general, they should have a particular focus on ensuring low-income schools can access data from other systems, especially when they lack effective data systems of their own. When teachers can easily access data and insights from other schools, students in low-income districts can still benefit from data-driven education in some capacity. Federal and state departments of education should coordinate to develop a knowledge-sharing portal for educators that make it easy for schools to share best practices that incorporate detailed student data, so that low-income schools can access effective models for their own students.

School districts should also ensure they have robust analytics systems that can bring unfair of discriminatory practices to light and prompt corrective action. For example, student information systems could flag for administrators when minority students as a group receive an abnormally large number of disciplinary actions and reveal that the teacher issuing these actions may be exhibiting subconscious or overt bias. And with granular data about student performance throughout the

whole school, an analytics program could reveal that certain groups of students are routinely underperforming, thus prompting a principal to investigate why and to offer supplementary tutoring programs, for example.

The federal government should continue and expand efforts to close the digital divide in the home, as EdTech increasingly relies on data collected outside of the classroom. The Department of Housing and Urban Development's (HUD's) ConnectHome program, a public-private collaboration to close the digital divide for families with children in school living in HUD-subsidized housing, could be expanded to have a specific focus on making home computers more affordable.[129] Similarly, policymakers should continue to engage the private sector and promote programs that can help eliminate data poverty—the social and economic inequality that results from a person's or community's inability to participate in data collection and use—for students, particularly in low-income areas. For example, Comcast's Internet Essentials program provides low-cost Internet access to qualifying homes, which could help ensure that students can take advantage of EdTech and access their data at home just as easily as in the classroom.[130]

Conclusion

It is time to bring American k-12 education into the 21st data economy. Just as other sectors increasingly rely on data to make smarter decisions, operate more efficiently and fairly, and develop innovate new solutions to problems, education should embrace data, too. In fact, given the implications of an effective data-driven education system—a more productive workforce, greater economic opportunity, and increased national competitiveness, to name a few—the need for policymakers to take action to address the shortcomings of the education system is pressing.

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