Evaluating the Implementation of Integrated Student Information and Instructional Management Systems

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I. INTRODUCTION

Integrated data systems that bring together student information collected at the classroom, school, district, and state levels in a way that can inform instructional decisions are considered one of today's most promising trends in education. Because these systems support decision making by teachers as well as by administrators and because some of them incorporate formative assessments and curriculum resources, they have the potential to blur the traditional distinction between administrative and instructional computing systems.

The Consortium for School Networking (CoSN) has made data-driven decision making one of its major initiatives and has commissioned two reports (*Vision to Know and Do* in 2004 and *From Vision to Action* in 2005) on the topic. The first of these articulated the high expectations for these systems:

> Educational enterprises have also begun to apply the strategies and approaches of knowledge management to their practice. Sophisticated data collection and dissemination technologies combined with a better understanding of how human beings learn *is transforming education* [emphasis added]. (p. 3)

This positive view is seconded in the recently released National Education Technology Plan 2004 (U.S. Department of Education, 2004), which highlighted the integration of data systems as one of its seven recommended major action steps and asserted that

> Integrated, interoperable data systems are the key to better allocation of resources, greater management efficiency, and online and technology-based assessments of student performance that empower educators to transform teaching and personalize instruction. (p. 44).

In recent years, systems to support the integration of data from different levels of the education system in a way that can support decision making have been or are being developed by commercial entities (e.g., SchoolNet, SCHOLARinc), nonprofit organizations (e.g., Center for Research on Evaluation, Standards, and Student Testing; National Study of School

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Evaluation), school districts (e.g., Montgomery County, Poway Unified), and states (e.g., Idaho, Virginia). This paper explores the drivers for this trend, the variety of systems now available, and the different purposes and emphases for their use, with the goal of helping to frame future evaluation research. It focuses on issues surrounding the use of the systems at the classroom and school levels, where they have the greatest potential to influence instruction and student learning.

Antecedents for Use of the Systems

The goals motivating education policymakers' interest in these integrated systems for student data are multiple. CoSN (2004) summarizes them as (1) improving outcomes for all students, (2) meeting external demands for data, such as those of No Child Left Behind, and (3) transforming the organization itself (i.e., the district or the school) through providing the data needed for continuous improvement processes. Each of these purposes has been a goal for education for many years, and earlier efforts in pursuit of these goals have generated advocates who now view the prospect of integrated student information and instructional management systems from a particular perspective.

Improving Instruction

The concept that instruction will be more effective if it is tailored to the performance level and pattern of strengths and weakness of the individual student has been around since the days of Skinner (1950) and mastery learning (Bloom, 1986; Keller, 1983). Back in the 1970s, teachers were urged to keep track of each student's pattern of mastery and nonmastery of specific instructional objectives, and professional development offerings included techniques for using computer punch cards and knitting needles to keep track of how students should be grouped and re-grouped based on their mastery profiles. For many years now, computer systems have been able to handle this record keeping and student management task much more easily. Instructional management systems are often a component of instructional software, but their use in organizing non-computer-based instruction has been less common.

A distinct but related concept is that of "differential instruction" (Sizer, 2001; Tomlinson, 2001). The basic idea is that students come to classrooms with different sets of experiences, cultural expectations, motivations, and preferred ways of learning. Teachers should adjust

both the curriculum and instructional approach to meet each student where he or she is, and hence should differentiate or personalize instruction in such a way that diverse learners can be well served within the same classroom. Having access to a student's prior assessment results gives the teacher information that can be used in planning an individual instructional program.

Accountability

Another impetus for integrating student information and instructional management systems is the increasing requirement for student data for accountability purposes. State and federal education offices have always had reporting requirements associated with funded programs. As districts and states sought to strengthen their accountability systems through the 1990s and the public concern over the quality of education led to the press for more school performance data, both government and commercial entities have become involved in developing data systems to store student performance data and other indicators of school quality (such as promotion and retention rates, attendance, and disciplinary rates). Litigation over whether schools are providing adequate opportunity to learn, given requirements for minimum test scores for promotion or graduation, have also increased the perceived need for districts and states to maintain strong student information systems. Districts may need to provide evidence that every student in a given course or grade level has been given instruction on each standard and to document students' proficiency levels with respect to individual standards. The information required by one level or office within the education system is often relevant to others. Avoiding duplication of effort and maximizing the benefit derived from data collection and storage are appealing to states and districts as they develop information systems for accountability.

Process Improvement

School administrators have long been encouraged to implement business practices emphasizing continuous improvement based on the use of statistical data. This practice is a central tenet of the "total quality" movement in business, which goes back to Deming's work guiding the recovery of Japanese industry after World War II. Educators have been encouraged to adapt the model to education (American Association of School Administrators, 2002; Schenkat, 1993; Schmoker & Wilson, 1995). Where a company might measure the proportion of computer chips passing quality control and obtain satisfaction data from its

customers, a school system might want to measure daily attendance and student achievement and to think of students, their parents, and community employers as "customers."

The process improvement movement is embodied most prominently today in the Baldrige National Quality Program sponsored by the U.S. Department of Commerce. The program emphasizes core values and processes found in high-performing businesses, including involvement of employees at all levels of the organization in strategic planning, examining data to assess current status and targets for process improvement, and setting up systems that generate a flow of data that can be used to inform a process of continuous improvement in the interests of providing higher value to customers. The Malcolm Baldrige Total Quality Award is bestowed on organizations that have demonstrated performance excellence through a rigorous self-assessment, documentation, and external review process using the Baldrige criteria and scoring system. In 2001 the Chugach, Alaska School District and the Pearl River, New York School District became the first districts to receive Baldrige Awards. The award is considered a rare and high honor for any organization. The Baldrige National Quality Program encourages educational organizations to adopt total quality practices with a separate award category and a tailored set of criteria for educational institutions.

Recent Developments that Have Made Integrated Systems Feasible and Attractive

While the expectations for integrated data systems are based in long-standing educational values, recent developments in both technology and policy have made the environment for developing and adopting these systems more fertile than in the past.

Technical Advances

Data Warehousing and Data Mining. Dramatic increases in computer processing power and disk storage capacity have prompted organizations to embrace the concept of data warehousing—i.e., the vision of having all of an organization's data in a central repository with centralized data management and retrieval that maximizes user access and analysis. The National Educational Technology Plan promotes data warehousing as a total information management system that combines library, human resources, special education, finance, food service, student information, and assessment databases into an integrated, interoperable system that "creates reports that everyone can access" (pp. 24-25). "Data mining" or the

process of turning the data available from multiple data bases into "information" and "knowledge" (as the current jargon goes), requires not just a data warehouse but also statistical software capable of performing analyses in response to user queries. Advances in the power, speed, and usability of analytic software has fueled the interest in data mining and data warehousing.

Web Interfaces to Complex Databases. Additionally, advances in networking and computer and web interfaces have been important enablers. The fact that a distributed set of users in multiple locations can all access the same integrated data base and that multiple levels of access and security can be applied to different portions of the information is important. Better web interfaces that make it much easier for a user who is neither a statistician nor a "power" computer user to query a database to obtain information about specific subgroups of students are also important. These advances make it possible for administrators and teachers to explore data sets themselves. As an advertisement for Sagebrush Analytics states the case:

> Administrators and educators are being held more accountable for school performance and student achievement. To measure what impacts student learning—and why—you need the right data. To effectively examine your district's data, you need a powerful yet easy-to-use analysis tool. (eSchool News, 2004).

Schools Interoperability Framework (SIF). One of the major barriers to integrated systems in education has been the fact that so many systems were separately developed and operating as "silos." The system tracking student lunches and eligibility for free or reduced-price lunch may be totally separate from and incompatible with the system housing student test scores. Human resources data are separate from the system housing student grades. The Schools Interoperability Framework (SIF) was launched in 1998 as a nonprofit initiative of the Software and Information Industry Association (SIIA). The purpose was the development and promotion of standards for K-12 education software so that data could be shared between different applications. The SIF specification defines a set of standard messages written in XML that can be sent using Internet protocols to the SIF "Zone Integration Server." The SIF Zone Integration Server is platform independent and vendor neutral, allowing data to flow between applications written by different vendors. Now an independently incorporated nonprofit organization, SIF works with software vendors and federal and state governments to promote its interoperability specification. Software that is

SIF compliant can be much more easily integrated with other software that is SIF-compliant; this promotes both linking of separate information systems within a school district and easier aggregation of data from separate district systems within a state. It also reduces the dependence of a school district on the particular vendor that happened to provide their current system. The National Educational Technology Plan encourages administrators to consider requiring SIF compliance certification in all requests for proposals and purchases (p. 44).

Policy Developments

Systems Aligned Around Standards. Emerging integrated student information and instructional management systems are attempting to bring together instructional resources, classroom-level instructional management systems, and district and state databases where student performance on mandated assessments is stored. Prerequisites for this system merger include not just the technical advances cited above but also the standards-based reform movement that preceded these efforts. When both the mandated assessments and classroom instruction are organized around a common set of content and performance standards, the state assessment results are relevant to the school's class assignment decisions and to the teacher's classroom instructional decisions. By the same token, students' performance within the classroom provides insight into their capabilities with respect to the standards that will be assessed on district and state tests. Thus, the state content and performance standards are the common metric to which the various levels and components of the education system are mapped.

NCLB Data Reporting Requirements. Prior to the No Child Left Behind Act (NCLB), accountability systems tended to stress average scores or the percentage of students meeting proficiency requirements within a school. Under these systems, schools with high proportions of high-performing students looked "good" regardless of how well or poorly they served smaller subgroups, and often students from low-income or non-English-speaking backgrounds lagged behind year after year. With the NCLB requirement to show adequate yearly progress for every subgroup of students defined by variables such as ethnicity, gender, poverty level, and English language learner, however, all schools need to attend to the performance of every subgroup containing 30 or more students. Given the accountability mechanisms in the legislation, school, district, and state-level administrators not only need to have systems

capable of generating the required reports, but also have the motivation to obtain as much information as possible regarding the performance of the various student subgroups within each school within their jurisdiction so that they can allocate resources appropriately while there is still time to help students raise their achievement levels prior to accountability testing. Moreover, because existing data systems in many districts were not capable of generating the reports that would be needed under NCLB, a window of opportunity was created for designing and implementing systems that were both technically and substantively superior to their predecessors.

EETT as Funding Source. As will be discussed at some length below, use of integrated student data systems places demands on school staff and requires not only skill in navigating and using the system interface but also some sophistication in data interpretation, diagnosis, and instructional planning. Given the lack of emphasis on analyzing data and drawing instructional implications from it in teacher preparation programs, professional development surrounding use of integrated student data systems at the school level is very important. The Enhancing Education Through Technology (EETT) program of block grants to states, with its provision that 25% of funds be used for professional development, provides federal funding that can be used for this purpose. At present, the proportion of teachers receiving EETT-supported professional development on data-driven decision making is not known. The National Educational Technology Trends Study (NETTS) teacher survey scheduled for later this year will provide this data. We do know that on a 2001 national survey, 36% of teachers said that they had had professional development around using technology to analyze student assessment results including state and district assessment data (Adelman et al., 2002). Given the proliferation of technology products supporting this kind of activity since the passage of NCLB (Stringfield, Wayman, & Yakimowski, 2005) and recent research reports describing such efforts (Cromey, 2000; Feldman & Tung, 2001; Herman & Gribbons, 2001; Light, Wexler, & Heinze, 2004; Mason, 2002; Thorn, 2002), it seems likely that professional development on how to use these systems to guide instructional practices is on the increase, probably with support from EETT funds for professional development.

Challenges and Barriers

While the technology needed to create integrated student information systems is available, converting and integrating the many different systems existing now and improving data definition, entry, and quality control processes so that the data stored in the systems is both complete and accurate are both major undertakings. It may be just a matter of obtaining the necessary combination of political will, time, and money, but Idaho's experience with its ambitious plan for a statewide student information and instructional management system (described in both the National Educational Technology Plan and in CoSN, 2004) suggests that this combination will be hard to sustain long enough to get working systems in place.

Just last year, the chief of Idaho's Bureau of Technology Services described that state's 10-year plan to create the Idaho Student Information and Management System as a "'one-stop' education system that includes maintenance of general student information, the ability for educators to access curriculum resources to aid in lesson planning geared to meeting state standards, and a reporting and analytic capability that lets different types of users gain a clear picture of how the Idaho educational system is performing for individual students and in the aggregate" (Mincer, 2004, p. 2). The plan called for a statewide student information and instructional management system that would incorporate assessment results, curriculum resources, and data analysis tools that would be accessible through a web portal. With $35 million from the J.A. & Kathryn Albertson Foundation as initial funding, the state awarded contracts to three different companies for development of the major system components (the student information, curriculum management, and reporting and analysis components of the integrated statewide system) and solicited districts to volunteer for the first phase of implementation. In December 2004, however, the foundation issued a press release stating that it had become clear that ISIMS was too complex and too expensive: estimates of the costs for the system over the next five years had risen to $180 million. In January 2005, the Idaho State Legislature Office of Performance Evaluations released a report describing ISIMS as "over budget, behind schedule, complex, and finally, cost-prohibitive." Phase 1 districts surveyed for the report said that on their side, implementing the system was "more expensive" or "way more expensive" than they had anticipated. Additional development was put on hold as the foundation and the state concentrated their efforts on helping the Phase 1 schools find other alternatives for handling their student information.

In addition to software integration and cost issues, the introduction of new student information systems can run into challenges on the human side. Information systems require people both to put information in and to take information out. To the extent that individuals have a choice, they will weigh the effort they must expend to interact with the system against the value they obtain from it. It is for this reason that system designers are increasingly turning to systems that derive information from transactions (for example, as bar codes are scanned in the grocery check out) so that most users don't perceive a system requirement for additional labor on their part. To the extent that the implementation of an integrated student information system requires teachers to spend extensive time either inputting classroom assessments and scores or abstracting data for their students, they are going to weigh the burden imposed against the benefits they perceive for their students. If teachers are expected to assume these new responsibilities in time beyond their normal work week without compensation, there is likely to be resistance (Cohn, January 12, 2005).

II. SYSTEM FUNCTIONALITY, VARIATIONS, AND TYPOLOGY

This emerging field has yet to settle on any standard terms or set of system categories or terminology. This paper's description of the system landscape is based on a review of readily available system descriptions. (Direct contact with states, districts, and commercial vendors were beyond the scope of this task.) Examining the features and uses system developers claim for their products helped to clarify the different functions these systems have and some of the variations in functionality and anticipated uses. First, I describe a set of key functions for the systems and then propose three dimensions that can be used to characterize the systems promoted for use in school-level data-driven decision making. This overview is written from the standpoint of characterizing key functionalities of systems relevant to the way in which they will be implemented at the school and classroom level, rather than trying to analyze technical qualities (such as the range of data formats accepted or system security for data transmission) or provide reviews of specific products. I have made no attempt to evaluate the technical quality or usability of systems, and mention herein does not constitute endorsement. Readers desiring reviews of commercial products, can refer to the Center for Social Organization of Schools web site (http://www.csos.jhu.edu/systemics/datause.htm) and the

technical report by Wayman, Stringfield, and Yakimowski (2004). Table 1 lists 17 commercial and noncommercial systems being promoted as integrating student data for data-driven decision making around instructional issues.

System Functions

Classroom Access to Students' Achievement Scores

The criterion for including a system in this review is its capability to provide school staff with access to information relevant to student instruction collected at different levels of the education system. Accordingly, all of the systems mentioned in this paper can be used by school personnel to view their students' performance on state-mandated tests. At a minimum, each system gives a school the opportunity to see the distribution of test scores or proficiency ratings for its students overall, by grade level, and by NCLB-defined subgroups (e.g., ethnicity, gender, limited English, eligibility for free- or reduced-price lunch). The software typically provides a "drill down" capability, allowing the user to click on a graph or table entry to get additional information on the students comprising the group represented by that statistic. Some of the systems incorporate a feature providing a classification of students with respect to Adequate Yearly Progress (AYP), showing the proportions meeting the state benchmarks, near meeting them, and clearly failing them (e.g., SchoolNet).

Classroom Access to Other Administrative Data on Students

In addition to providing school staff with access to the assessment data for their students, many of these systems incorporate other data elements that may be part of administrative records maintained at the district level. These include elements such as previous school attended and grade enrollment and promotion. Some systems (e.g., eScholar, EDExplore, DataPoint) support school-level access to all the information maintained on a student across multiple years, the equivalent of an on-line student profile approximating a cumulative record.

Query Tool for Flexible Report Generation

All of the systems offer a set of preformatted reports, and most also provide a query feature system that allows the user to define groups of students for which they would like reports or to generate reports on different sets of user-selected variables. This flexible query function is important in tying the systems to school decision making because often school staff will want to select the variables they care about as part of their self-improvement efforts. Schools may implement special programs for subgroups of students, for example. The tool can help identify those students in most need of additional opportunities to learn and, after a special program has been implemented for a year or more, be used to help evaluate the effectiveness of the program.

Incorporation of School- or Classroom-Generated Data

Some of the system providers stress a process in which schools examine their data needs and resources and decide what kinds of data to include in their system (e.g., NSSE, TetraData). Schools may choose to include a wide range of types of data, including results of teacher-developed tests, student participation in special school-level programs, teacher evaluations, results of student or parent surveys, or interview data. The inclusion of this broader set of data is particularly likely in cases where the use of the system is part of a comprehensive quality management or school improvement process emphasizing data-driven decision making.

Incorporation of Student Work Samples or Portfolio Content

Some of the systems allow the incorporation of samples of scanned student work or electronic portfolios (e.g., DataPoint, QSP). Inclusion of these student products is viewed as a way to provide an alternative lens on student capabilities, which can be viewed by administrators and parents as well as school staff. Reports on how the systems are actually used, however, suggest that many implementations never progress beyond test scores.

Linkages Between Assessment Results and Content Standards

Many of these systems incorporate a link to district or state content standards as a support for instructional decision making based on the assessment results. If students in a particular

grade or class score poorly on the state mathematics assessment, for example, the teacher or administrator can link to the standards that are supposed to be measured through that assessment (or in some cases, by particular subscales on the assessment) in order to get a better sense of where the class's or school's instructional program may be weak. The linkage to standards is important because large-scale assessments generally provide data on only a handful of subscales, and subscale names do not completely or unambiguously specify their content. Thus, administrators and staff need supports to move from the more macro level represented by assessment results to the micro level needed for instructional planning. Some have argued that given issues of currency, grain size, and score reliability, this mapping to content standards is not sufficient to inform instruction (Confrey & Makar, 2005; Thorn, 2002), but vendors view it as a key selling point for these systems.

Lesson Planning Resources

Identifying student needs with respect to AYP or state proficiency standards is just one step in improving student outcomes, of course. The next steps include instructional planning and then provision of learning experiences that will enhance student performance. Once assessment results are mapped to content standards, it is theoretically straightforward to link to instructional resources mapped to those same standards. This linkage does not appear to be a feature of many of the commercial systems reviewed by Wayman, Stringfield, and Yakimowski (2004). It is found, however, in Virtual EDucation and was part of system plans developed by Virginia and Idaho.

On-line Benchmark Assessments or Test Preparation

Some systems emphasizing instructional use of assessment data are moving toward the incorporation of on-line assessments into the integrated system. "Benchmark assessments" are on-line assessments linked to standards that students can take throughout the year. More hours may be consumed and many more items can be included on benchmark assessments taken throughout the year than would be acceptable on a once-a-year accountability test. For this reason, these benchmark assessments can provide more fine-grained information regarding student competency with respect to specific instructional objectives or standards than can be obtained from annual accountability tests, and thus such assessments are more

useful to teachers in planning instruction. Benchmark tests are promoted also for their utility in helping teachers and administrators gauge the likelihood that particular students will demonstrate proficiency when the accountability test is given at the end of the year. Performance on the on-line assessments provides a "benchmark" for predicting a student's performance on the state's accountability test.

Virginia offers a prominent example of a statewide initiative to integrate student data systems with on-line assessments. Over 400,000 on-line assessments geared to Virginia's Standards of Learning have been taken by the state's students, and the plan is to make results available to state and local administrators as well as teachers to support instructional planning at every level of the system (U.S. Department of Education, 2004).

Some of the commercial systems tout test preparation or practice in their advertising, suggesting that the systems themselves can provide the experiences students need to improve their performance on accountability tests (as opposed to the system's online assessments providing insights to the teacher who then provides appropriate off-line instruction that will raise test scores).[1]

Interface for Parents

Some of the systems (SchoolNet, Virtual EDucation) and system implementation initiatives incorporate access for parents or the general public. With these systems, parents can see their child's mastery profile with respect to grade-level standards or how their school is performing on accountability tests compared to other schools in the district or state. Some large-scale implementations support parent comparisons of student performance at all the schools in the district.

Dimensions of System Variation

Any categorization of complex innovations is necessarily an over-simplification, and many innovations (or in this case, integrated systems) will blend characteristics of multiple

[1] There are systems also that provide on-line benchmark tests but that are not integrated with a student information system; these fall outside the scope of this review.

types. In general, though, integrated student information and instructional management systems have not been developed to the extent that any one of them encompasses the full breadth and depth of the visions laid out by CoSN and the National Educational Technology Plan. At present, individual systems tend to reflect their varying origins and the strengths of their developers and to be stronger in one area than in others. In this section I identify three dimensions along which today's systems vary. These dimensions, and the levels within them described below, generate a 2 X 3 X 2 classification scheme that is displayed graphically in Figure 1.

Degree of Emphasis on the School as Client

All of the software systems used as examples in this paper integrate information from different levels of the education system, but system providers tend to think of one level of the system or another as their starting point and chief "client." Some of the system providers focus on working with districts on district-wide implementations (e.g., Chancery, SchoolCity, TRIAND). Others are more geared toward working with individual schools (e.g., SchoolNet, TetraData, eScholar, CRESST). The latter tend to offer systems stressing tailoring to a school's perceived needs and to be designed to incorporate a broader set of school-generated information. Many of the systems in this latter category are promoted as part of a school improvement process. A few systems even incorporate resources to support staff training and school-level improvement processes based on analysis of data.

Degree of Emphasis on Supporting Instruction

A few of the systems have a strong instructional improvement component. These systems are more likely to include resources for lesson planning or instructional materials linked to standards. Virginia's system, built around the state's Standards of Learning, is one example. Idaho's plan for ISIMS to include a curriculum management component based on Orion, a system from PLATO Learning, was intended to be another.

Degree of Incorporation of Formative Assessments

As noted above, some of the systems include components for student use as students take benchmark or formative assessments. These are integrations of assessment and information systems. Virginia's system illustrates the positive end of this dimension as does the

commercial TIES system from TRIAND. Other systems do not deliver assessments, but are designed to incorporate the results of teacher-developed assessments so that system users can bring together classroom and accountability test data on reflecting on their students' progress and needs. Other systems neither incorporate on-line assessments nor accept the results of school-developed tests.

III. PRIOR RESEARCH

Not surprisingly given the emergent state of these integrated student information and instructional management systems, empirical research on their use at the school level has come into the literature in just the last five years or so. Several researchers have provided positive reports of successful implementations (Cromey, 2000; Feldman & Tung, 2001; Light, Wexler, & Heinze, 2004; Mason, 2002). In their study of the implementation of the Grow Network reporting system within the New York City Department of Education, for example, Light, Wexler, and Heinze (2004) studied use of data within 15 New York City schools. On surveys and in interviews teachers reported using assessment data for their students in both broad and specific planning. They said they used the data to help set priorities for the class as a whole and for doing weekly and yearly lesson plans. They said they used the data also in constructing specific daily lesson plans and mini-lessons. Teachers reported using data for individual students to better tailor instruction to that individual student, providing material that was at his or her level. They also used the reports as a basis for grouping students (sometimes purposely doing heterogeneous grouping) and for pairing high- and low-achieving student s for peer tutoring. The study did not attempt to measure any achievement gains related to use of the assessment data, and it is not clear how much of the information obtained in the student information system reports simply confirmed things teachers already knew about their students' achievement levels.

CoSN (2004) reports the experience of a high school science teacher in the Poway Unified School District who learned through using his district's new information management system that the reading level of his students was well below the level at which the science text was written. This information led him to obtain new, more appropriate curriculum materials for his students.

Herman and Gribbons (2001) studied a high school whose students overall did well against national norms but that had a subgroup of economically disadvantaged English language learners coming from outside the local area who had poor test scores. Looking at the data more closely, the staff discovered that poorer attendance and a low likelihood of enrolling in more demanding mathematics courses were associated not so much with where the students lived as with where they had attended middle school. A misalignment between the mathematics sequence at the high school and that for some of the middle schools outside the local area made it difficult for students from those middle schools to enroll in a higher-level math course in ninth grade. Examination of their data and practices led staff to adopt a view of these incoming students' math deficiencies based more on their prior learning opportunities and less on their SES.

One conclusion drawn from several of these case study reports is that schools that have implemented data-driven decision making successfully have had a pre-existing common vision and a supportive leader who promoted the process (Cromey, 2000; Herman & Gribbons, 2001). They also set aside supported time for teachers to engage in the process of data review and reflection.

The optimistic picture sketched above is balanced in the literature by a number of concerns. Many teachers and administrators express distrust of standardized test scores (Cromey, 2000; Herman & Gribbons, 2001). Thorn (2002) points out the mismatch between the kinds of data that are usually available and the recency and specificity of information teachers need to guide instruction:

> Typically, the only outcome data available are the results from centrally administered tests (which are often annual events) and grades. While this data is useful to help frame annual analysis of school-, classroom-, or student-level outcomes, it is inadequate for making mid-course or interim instructional decisions within a single grade/marking period.

Teachers express a preference for "real-time data" relevant to their internal groupings of teachers and students (Mason, 2002).

Even the promoters of data-driven decision making acknowledge that most teachers and administrators lack training in using data to make decisions (Choppin, 2002; Cromey, 2000; Herman & Gribbons, 2001). Standard reports generated by assessment systems are often

confusing to teachers, and even with the new, user-friendly reporting formats, it is not clear that teachers appreciate such basics of assessment and statistics as measurement error and sampling bias.

Several studies (Confrey & Makar, 2002; Light, Wexler, & Heinze, 2004) have found that both teachers and administrators using student assessment data tend to focus on the "bubble kids"--those just below the criterion for proficiency. Their rationale is that these are the students who, with a little work, can be brought over the threshold for proficiency, improving the school's progress metric. What school staff fail to appreciate, as described in a case study conducted by Confrey and Makar (2002), is that given measurement error, many of these students would be expected to score above the cut point on a second testing without any intervention and some of those students who were just above the proficiency level on last testing have a similar likelihood of scoring below the criterion on the next testing if there is no growth in their underlying proficiency. Moreover, as the authors point out, the focus on the "bubble kids" leaves those who are farthest behind in a state of neglect.

The research conducted thus far has tended to focus on identifying supporting conditions and challenges for implementing school-level decision making based on assessment data. There is a pronounced lack of data on the prevalence of use of these systems, and a lack of evidence with respect to how they are affecting instruction or student achievement.

IV. CONCEPTUAL FRAMEWORK

The rationale for school use of integrated student information and instructional management systems and the research literature reviewed above suggest a conceptual framework which can provide a basis for generating research questions and study designs. The goals of implementing these systems can be classified into two distinct sets. The first deals with student achievement and learning outcomes. Promotion of data-driven decision making within schools is based on the premise that this practice will lead to improvements in achievement for students generally, and also to a narrowing of achievement gaps between different student subgroups. The second set of outcomes, as shown in Figure 2, consists of system outcomes. The systems are expected to provide the access to student data that can be

used as part of more efficient decision making and continuous improvement processes, thus leading to a higher level of professionalism among school staff. An added expected benefit is the cost savings that can accrue through the elimination of redundant data collection and storage tasks. Another system outcome, stressed in some but not all implementations of these systems, is better communication with parents and parent access to more information about their children's progress.

The dotted box surrounding school-level data-driven decision making in Figure 2 illustrates the fact that this activity may be undertaken within the context of a more wide-ranging school-level continuous improvement process. Much of the literature encourages this approach, but it is not universal. A second dotted box shows the supporting role of professional development around the use of these systems and the interpretation of data. The existing research literature suggests that this practice is badly needed, but that its implementation varies across sites. Similarly, the extent to which the district and state within which the school is located have in place an aligned system built around content standards and emphasizing school-level accountability is likely to vary from place to place. Jurisdictions with stronger rewards and sanctions are likely to have schools that are more motivated to spend time examining and acting upon student data. One could conjecture that better alignment of tests and instructional resources around content standards (and perhaps integration of standards-linked instructional resources within the integrated student information and instructional management system) would have a positive influence on school implementation of data-driven decision making.

Figure 3 provides more detail concerning the intermediate steps within the logic chain—i.e., the steps that are necessary to link the availability of data to desired outcomes. School staff must not only spend time on data-driven decision making, but the data they have access to must be timely and relevant to the kinds of decisions they are making. Thorn (2002) and others have pointed out that the assessment data available in these systems is usually limited to standardized test scores that are months old and at a level of granularity too gross to inform daily and weekly instructional decision making. System developers point out that their systems can accommodate whatever kinds of assessment information schools and districts put into the system, so this problem is one of implementation rather than an inherent limitation.

Assuming access to data that is both timely and relevant to school-level decision making, school staff need the ability to form sound interpretations of the data. The literature suggests that there are issues both around the interfaces and data representations that different systems offer and also around the training that educators receive.

Assuming that educators have been able to draw appropriate inferences from a data set (for example, to discern a pattern of persistent differences in student outcomes related to variables within the school's control), the staff must be able to formulate appropriate instructional strategies based on the data. It is quite possible that a school staff could learn that they are not succeeding in promoting an understanding of important concepts in mathematics or writing among a subgroup of students, but not have any techniques to use to address that deficiency.

Finally, assuming that educators have access to relevant data, are able to interpret it appropriately and derive sound instructional prescriptions, they still have to *implement* those prescriptions in their classrooms if they are to influence student experiences and learning. Teachers may know what they should do according to research or generally accepted "best practice," but still not do it because of the required time, effort, or resources or because of a conflict with their own beliefs about good instruction.

V. EVALUATION QUESTIONS

The conceptual framework sketched out above and depicted in Figures 2 and 3 suggests that there are a good number of significant steps required to move from data availability to improved student outcomes. The length and complexity of this chain of events have implications both for implementation planning and for evaluation design. It suggests that one would want to examine the settings within which the systems are implemented to discern whether supports (e.g., professional development and other forms of guidance) were provided for each step: reading data correctly, drawing inferences concerning student strengths and weaknesses from data, drawing inferences concerning program weaknesses from the pattern of student performance, developing instructional prescriptions based on data, and implementing the instructional prescriptions. If any of these steps proves to be deeply

problematic (as some of the research literature suggests they will), the integrated student information and instructional management system's potential payoff will be compromised. Understanding the support practices that are most effective in supporting school- and classroom-level decision making based on data is important.

The emergent state of these systems and the lack of national data on their use or effectiveness suggest a three-part research agenda examining:

- the prevalence and distribution of integrated student information and instructional management systems
- supports provided at each step of data use and the association between different types of supports and greater school use of the system
- relationship between system use and changes in teacher practice and increases in student achievement.

Couching this agenda in terms of specific research questions, I would suggest evaluation studies asking:

1. How broadly are these systems being implemented?
2. How much and what kinds of training do teachers receive in their use?
3. What are teachers' perceptions of the systems' usability and utility?
4. What kinds of conclusions and inferences do teachers draw from the student data they retrieve from these systems?
5. What changes in classroom practice (e.g., differential instruction, greater use of formative assessment, changed grading practices) are associated with use of these systems?
6. What kinds of teacher training and support are associated with greater and more appropriate use of these systems to inform instruction?
7. Does use of these systems improve student achievement?

Given this wide range of questions and the recency of not only research on implementation of integrated student data systems but the systems themselves, multiple methodological approaches will be needed. Basic questions concerning prevalence of the integrated student information and instructional management systems and their basic features and uses (Question 1) can be addressed through survey research. Ideally, this would be done in connection with other educational technology or instructional practice data collection efforts. In addition to compiling information concerning states' integrated student information system development and implementation plans, the Department of Education should consider a national survey of school districts concerning their activities and plans in this area. In both cases, it is important to obtain information on the quantity and nature of training and support provided to teachers for use of the systems to support instructional decision making (Question 2).

Teacher surveys can include items concerning the frequencies with which teachers use student information systems, the system functions they use, the purposes for which they use them, and the perceived usability and utility of the systems (Question 3). Teacher survey items would need to be carefully crafted, however, to minimize teachers' tendency to give what they believe is the socially desirable response, especially in the wake of all the hype around data-based decision making. In addition, survey data should be supplemented with more detailed, descriptive information collected by evaluators who will have some opportunity to observe the teachers' practice.

I would recommend addressing Questions 2-6 through a set of in-depth case studies, conducted in districts that have fielded or are in the process of fielding, integrated student information systems. The dimensions illustrated in Figure 1 (i.e., primary client, formative assessment emphasis, instructional resource emphasis) provide a framework for choosing a sample of system implementations for in-depth study. Interview questions and document reviews conducted as part of the case studies should cover the major categories illustrated in Figure 2 (e.g., degree of alignment of the teacher's curriculum with the state or district's curriculum and testing, nature and strength of the accountability system, professional development received around data-based decision making, timeliness of access to student

data, kinds of data interpretations made, examples of instructional decisions made on the basis of data, how data-based decisions were enacted, perceptions of differences made for student experiences, etc.) In addition, the study might want to incorporate a structured assessment of teachers' ability to form appropriate interpretations of student data and to derive instructional implications from it. Performance assessments of these skills could be developed using hypothetical student data and administered in conjunction with case study site visits.

A potential resource for the evaluation studies is automated information abstracted from system use files. Because the systems are web-based, it should be possible to identify the schools, if not the individuals, who are using the system most frequently. This information can provide a basis for selecting case study sites or classrooms or could become an independent variable in correlational analyses relating system use to achievement gains (provided that an adequate number of districts can be found with substantial variation in extent of system use in states with student-level identifiers permitting value-added analyses of student achievement).

A more convincing evaluation of the effects of implementing an integrated student information system on student achievement would be provided by an experiment or an interrupted time series analysis of achievement in a large district doing a phased roll out of a well-designed system with strong support for implementation. Achievement gains in schools implementing the system during the first phase could be compared to those for schools delaying implementation until the second phase. Such a resource-intensive study makes sense, however, only if one or more districts meeting study requirements can be identified and earlier research has established a case that the links in the logic chain shown in Figure 3 have a reasonable likelihood of being implemented. That is, one would want evidence from the survey and case study research that (1) teachers do access data on their students; (2) that given student data, teachers form reasonably accurate interpretations of it; (3) that teachers can match instructional strategies to their data interpretations; and finally (4) that teachers or schools implement those instructional strategies. Only if these skills and processes are in place in a significant number of schools and classrooms would we expect to see positive effects on student achievement.

VI. CONCLUSION

Great hopes have been expressed for integrated student information and instructional management systems (CoSN, 2004, 2005; U.S. Department of Education, 2004). Their development and fielding is one of the growth areas for school technology. Given the advances in information systems and the move toward data warehousing approaches in other sectors, one could argue that it's a foregone conclusion that schools will follow suit. What is less of a foregone conclusion, however, is whether districts and schools will find efforts to combine student information and instructional management functions in a single integrated system to be worthwhile. I have not dwelled on the considerable challenges of data cleaning, technical interoperability, and system integration costs. Instead, the focus of this paper has been on the challenges that remain once a workable system has been fielded. If schools and teachers are to use these systems to improve their instructional practices, the systems need to provide information that practitioners value and to do so in a way that is easily accessible. Teachers, moreover, need to know how to interpret data correctly and to be able to draw defensible instructional implications from their data. Schools and districts need to provide time and technical support for teachers to interact with data, make sense of it, and plan instruction based on it. Research examining variations in practices and system usage could do much to help identify the biggest challenges in school-level implementation and to establish best practices for dealing with them.

Table 1

Examples of Products for Integrating Student Information and Instructional Management

Source		
Commercial Vendors	***Nonprofit Organizations***	***Education Agencies***
Account & Align from SchoolNet	*Data Point* from NSSE	*ISIMS* Idaho
Ease-e from Tetra Data	*QSP* from CRESST	*Standards of Learning* Virginia
EDExplore from EDSmart		Broward County (FL)
E Scholar from SCHOLARinc		Montgomery County (MD)
Sagebrush Analytics from Swift Knowledge		*TIM* Poway Unified School District (CA)
SAMS from Executive Intelligence		
STARS from School City		
TIES from TRIAND		
Virtual Education from Edmin		

Figure 1. Dimensions of Variability for Integrated Student Data Systems

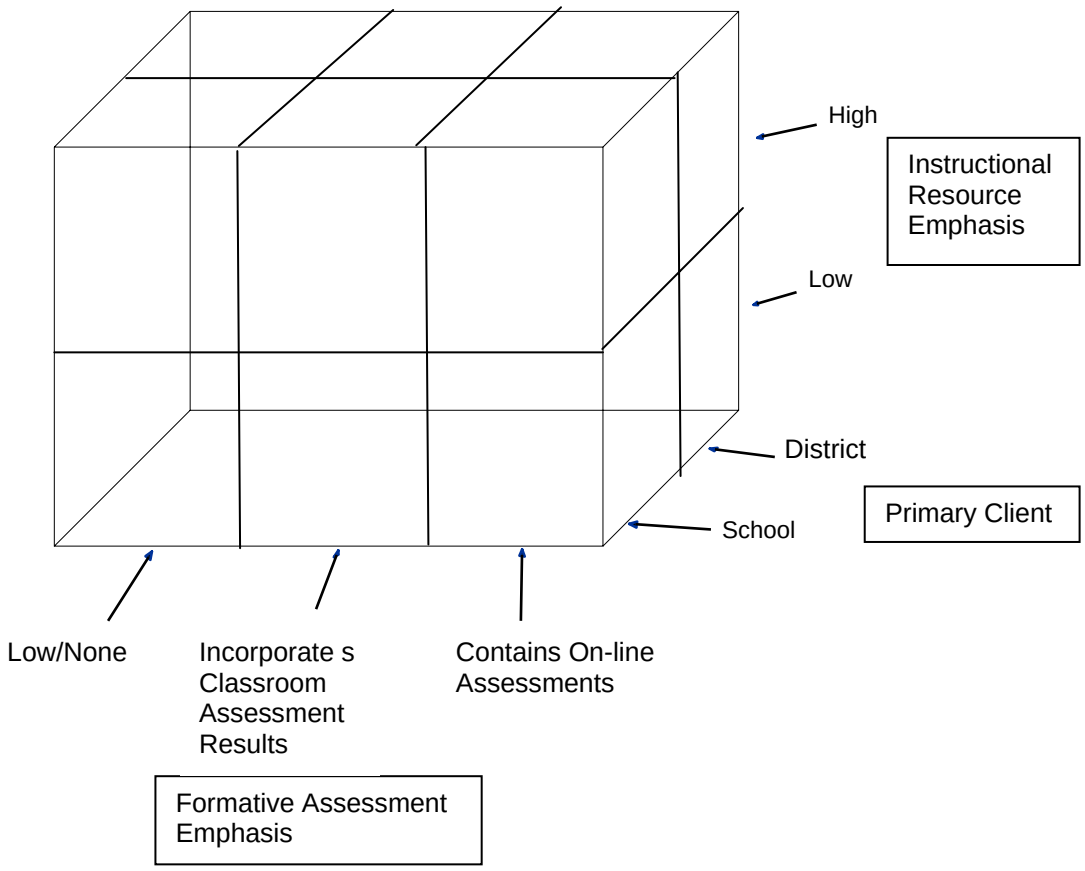


Figure 2. Overview of Conceptual Framework for School-level Data-driven Decision Making

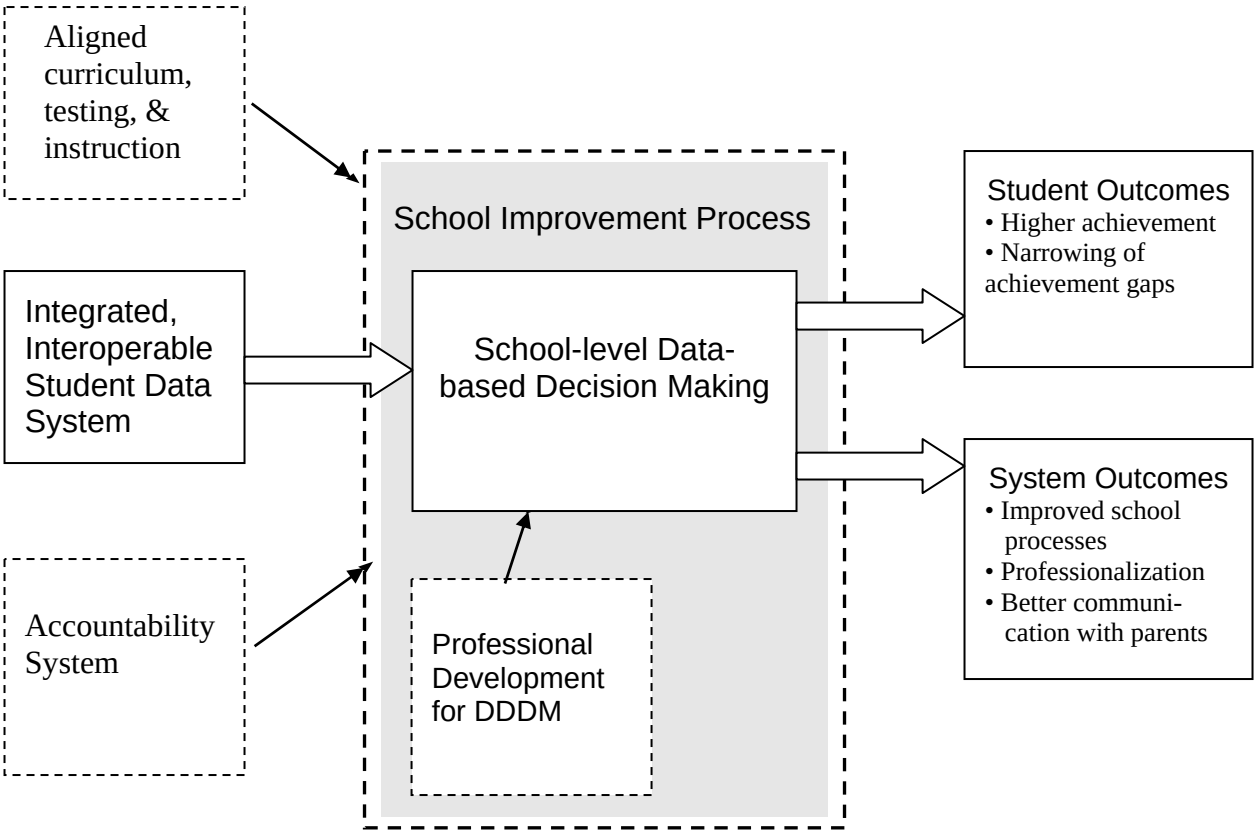
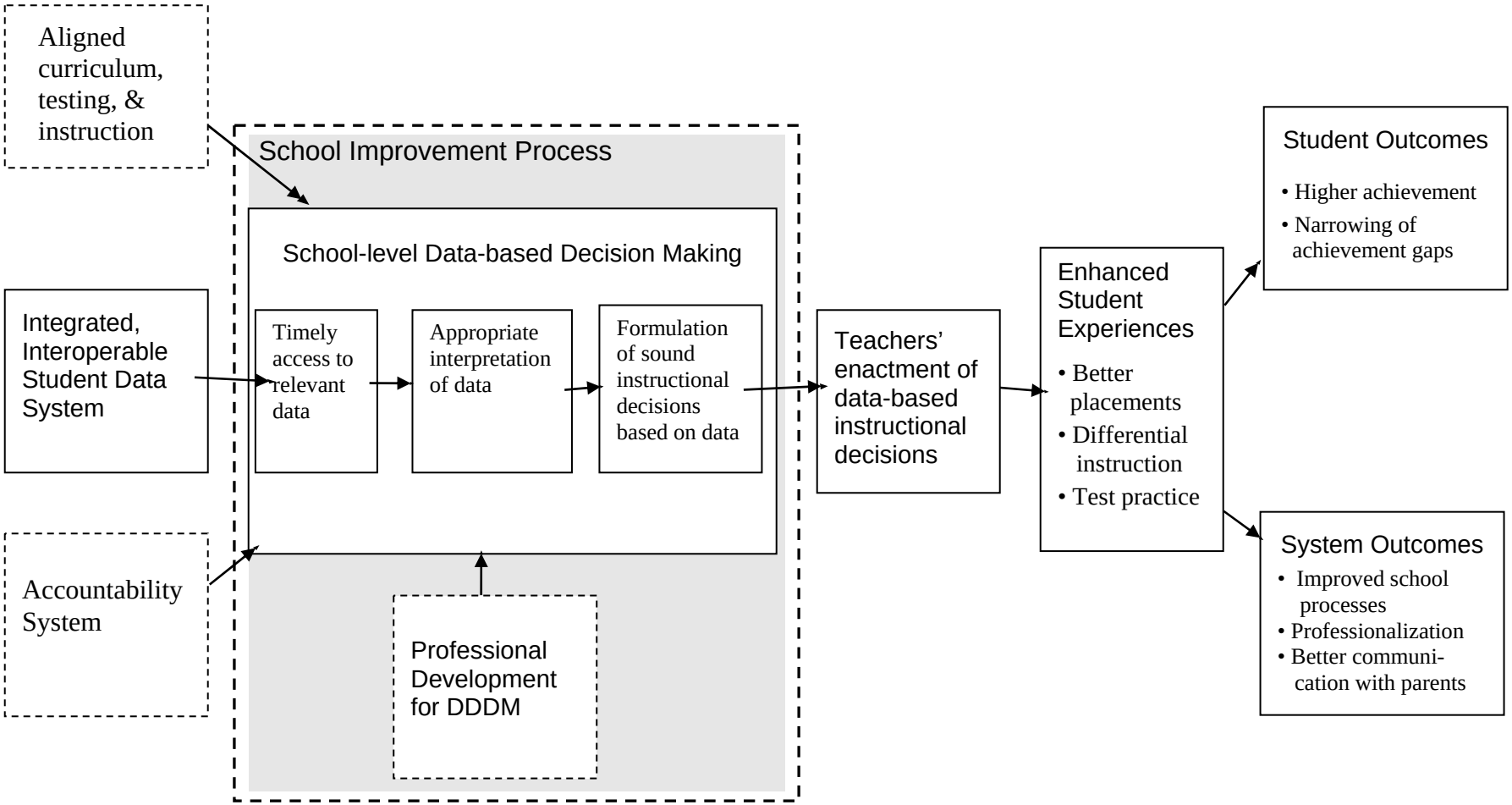


Figure 3. Detailed Conceptual Framework for School-level Data-driven Decision Making



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