SOFTWARE ENABLING SCHOOL IMPROVEMENT THROUGH ANALYSIS OF STUDENT DATA

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THE CENTER

Every child has the capacity to succeed in school and in life. Yet far too many children fail to meet their potential. Many students, especially those from poor and minority families, are placed at risk by school practices that sort some students into high-quality programs and other students into low-quality education. CRESPAR believes that schools must replace the "sorting paradigm" with a "talent development" model that sets high expectations for all students, and ensures that all students receive a rich and demanding curriculum with appropriate assistance and support.

The mission of the Center for Research on the Education of Students Placed At Risk (CRESPAR) is to conduct the research, development, evaluation, and dissemination needed to transform schooling for students placed at risk. The work of the Center is guided by three central themes—ensuring the success of all students at key development points, building on students' personal and cultural assets, and scaling up effective programs—and conducted through research and development programs in the areas of early and elementary studies; middle and high school studies; school, family, and community partnerships; and systemic supports for school reform, as well as a program of institutional activities.

CRESPAR is organized as a partnership of Johns Hopkins University and Howard University, and is one of twelve national research and development centers supported by a grant (R117-D40005) from the Institute of Education Sciences (IES, formerly OERI) at the U.S. Department of Education. The centers examine a wide range of specific topics in education including early childhood development and education, student learning and achievement, cultural and linguistic diversity, English language learners, reading and literacy, gifted and talented students, improving low achieving schools, innovation in school reform, and state and local education policy. The overall objective of these centers is to conduct education research that will inform policy makers and practitioners about educational practices and outcomes that contribute to successful school performance.

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ABSTRACT

The No Child Left Behind legislation has drawn increased attention to student data. Data are most useful in educational decision-making when the purpose extends beyond vertical accountability and toward school- and classroom-level decision-making that enhances the experience and achievement of students. This necessarily involves getting practical data analyses into the hands of teachers and administrators. Recent technological advances in data warehousing and presentation have resulted in tools that can, in theory, facilitate educator use of student data. However, the use of these tools is not yet widespread. The resulting condition is ripe for both educational improvement and research. In this report, the authors consider issues surrounding the use of student data and data based decision-making, describing the state of the field and possible future directions, present reviews of a range of commercially available software for analyzing student data, and provide and maintain a website that will contain ongoing updates of software reviews.

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A Near-Term Vision

Ms. Lockhart, a middle-school teacher, arrives at her desk with 15 minutes to spare before her academic day begins. She checks the control panel on her desktop computer. Fernando and Jamaal will be absent (their parents have phoned or emailed); Susan will be back from four days of family vacation. Both Susan and her mother promise that she'll make up her schoolwork over the weekend.

Last night, Ms. Lockhart finished grading her third-period students' projects. She uploaded their grades into her grade book. Projects submitted electronically were uploaded into students' portfolios. On the way to her office, she left the other projects at the front desk to be scanned in by a first-period student worker.

Scotty's work had been particularly troubling to her, with odd spelling errors and occasional words omitted. This morning, she opens his electronic portfolio and notices similar problems in his third- and fifth-grade products, with substantial variance in achievement test scores over time. Ms. Lockhart doesn't have a lot of time today, so she sends an email to the special education diagnostic team, asking that someone look at the latest document and at Scotty's prior work and test scores.

She quickly opens today's lesson set: English grammar for most students, with three students retaking a quiz they failed last week and three other students writing extra-credit book reports.

The bell rings, her students arrive, and first period begins. Janie is absent for the fourth consecutive day. Ms. Lockhart's completion of the electronic roll book will automatically signal the main office to contact Janie's family.

With 15 minutes to go in the period, Ms. Lockhart informs the students that their homework assignments are both on the screen at the front of the class and in their email files. She checks the three students' retaken quizzes, congratulates two (and enters their new grades in her electronic grade book), and assigns a different type of review to the third student. Ms. Lockhart emails the third student's mother, asking her to double-check the boy's homework tonight, and to email back if there are things the teacher should particularly attend to over the next week.

With two minutes to go in the class, Ms. Lockhart informs students that their end-of-term grades will be available in their web folders and on paper in a week. She will be asking several students and a few parents to come in for shared problem solving before the next semester begins. Most of the class, she says reassuringly, is doing well, and several students have shown remarkable progress this semester.

A look at her computer desktop reveals a new message: Janie's family moved without giving notice to the school. Ms. Lockhart sighs and writes a brief email to the receiving teacher, attaching a copy of Janie's permanent record to the email. She tells the class that they won't be seeing Janie any more, but that she is well and at another school in the district. She offers to forward any "goodbye" email messages that anyone would care to send.

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Ms. Lockhart uses a few extra minutes at the end of her day to explore some data disaggregation. She finds that her students on free lunch have been improving on both the state and local assessments this year. She is happy about that, since narrowing the achievement gap between her advantaged and less-advantaged students was one of her goals at the beginning of the year.

The bell rings and 28 preteens bound out of their seats and into the hall, talking and laughing and moping and picking on each other, just as their grandparents did 50 years earlier. In several senses, nothing is different about this school scenario. Parents still pull children out of school to visit grandparents or doctors or to go to Disneyland. Teachers still don't have enough time to meet with special education specialists, or to go to the office to look through a child's permanent record.

Yet a great deal is different. Ms. Lockhart keeps her attendance and grade book electronically. At a moment's notice, she can not only see students' products from her classes, but also view products from years gone by. She can forward a special education initial referral to the proper team with a few mouse clicks. Parents can leave messages for teachers, and by 9 a.m. every day can double-check that their children actually showed up for their classes. The technology that assists Ms. Lockhart is doing several of the things technology does best—efficiently storing and retrieving data, and moving relevant information to the people who can most professionally act upon it. Ms. Lockhart, who was not significantly better prepared to become a teacher than her predecessors of 10 years earlier, is nonetheless a significantly more efficient, more effective educational professional.

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INTRODUCTION

N.L. Gage, editor of the first *Handbook of Research on Teaching* (1963), regularly states that he has been told throughout his long career: "Computers are going to totally transform education—it's just around the corner." He reports that a 50-year corner is something at which to gaze in wonder (Gage, personal communication). Computers offer a wide array of capabilities and uses that are directly applicable to education, so why have computers not yet transformed education? Why has their implementation in our classrooms and schools been slow? Why is our vision for Ms. Lockhart a vision, and not a reality?

We termed our vision for Ms. Lockhart a "near-term" vision because we believe events are aligning that suggest that educators may soon begin turning Gage's 50-year corner. Today there is a clearly heightened emphasis on school use of data. The accountability requirements of the federal No Child Left Behind (NCLB) legislation have only increased this trend.

Software companies are increasingly interested in the education market and are continually introducing improved technology into the market. Perhaps most importantly, advances in computer hardware and software have made practical solutions to data use dramatically more cost-efficient. We all readily witness the remarkable increase in raw computing power and greatly reduced costs that have marked computer development over the years.

We believe that the potential for an impactful use of computers lies in putting the great quantities of student data already owned by schools into practical service. Schools, districts, and states have collected large amounts of student data for years, but this data is typically not put to classroom use. It is not unfair to suggest that today's schools are data-rich but information-poor.

Our belief is that teachers would make valuable use of data to inform their classroom practice if such data were quickly and easily available to them in forms that fit their needs and answered their questions. Software packages to facilitate such data use are currently in the market, and these packages can be implemented by wealthy and impoverished districts alike. In this report, we describe the software possibilities that exist in this area and explore what is potentially available for the foreseeable future.

RESEARCH ON SCHOOL DATA USE

Research on school improvement and school effectiveness has shown data use to be central to the school improvement process (Chrispeels, 1992; Earl & Katz, 2002), and there are many case studies available describing the variety of ways in which data has supported educational decisions (e.g., American Association of School Administrators, 2002; Feldman & Tung, 2001; Lachat, 2002; Pardini, 2000; Protheroe, 2001). Recent policies at the federal, state, and local levels have served to bring data use to the fore. As Earl and Katz (2002) note, data use is now not a choice for school leaders, but a must.

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Data can be used to inform solutions to a wide variety of educational challenges. Streifer (2002) listed exploring group differences, exploring growth over time, program evaluation, and identifying root causes of educational problems as being among the many ways data can be used. A study by Chrispeels, Brown, and Castillo (2000) showed data use to be a strong predictor of the efficacy of school improvement teams. Data use not only increased efficacy directly, but served as a mediator for the positive effect of other factors. Kennedy (2003) included use of data as a central component of his model for raising achievement test scores.

Data also can have a positive effect on the people involved in the educational process. Feldman and Tung (2001) observed that schools involved in data use often evolved toward a more professional culture. Educators in their study became more collaborative during the data/decision process, and school business consequently became less "privatized." Earl and Katz (2002) note that school leaders involved in data use often develop a mindset of being in charge of their own destiny, increasingly able to find and use information to inform their school's improvement. Armstrong and Anthes (2001) found that data use was helpful in raising teacher expectations of at-risk students, noting positive changes in teacher attitudes regarding the potential success of previously low-performing students.

Although data use provides many positives, the process of increasing data use in schools is not necessarily an easy one. One obstacle, in particular, involves technology. Although computers supporting knowledge management have been in widespread use in areas such as business, Thorn (2001) states that schools present difficult technical problems because of the variety of data needs and uses in school organizations. School data is often in disparate forms and locations, making it difficult to organize into an efficient database. To underscore this point, Thorn described a case study where a district was ready to implement data based decision-making, but technological barriers hindered the process. Recent technological advances are helping schools overcome these technological barriers. Stringfield, Wayman, and Yakimowski (2003) forecast that schools soon will have a variety of affordable, efficient computer tools to aid in the data process.

INFORMATION MANAGEMENT

Schools and districts have a new opportunity to provide professional educators, students, and their parents access to large amounts of student information. Today, schools can enable key decision-makers (e.g., teachers, principals) with data and information to facilitate more informed decision-making and improve school performance.

This concept is not new. Known broadly by many terms, depending on the field (e.g., "information management," "knowledge management," "data based decision-making"), this concept is indispensable in non-educational settings such as business and industry. In several areas of our society, ranging from retail store chains to airlines, highly sophisticated tools for delivering information to those in position to use that information are already part of standard business practice.

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The last major impediment to widespread implementation of data use for educational decisions exists at the software level, and we believe this hurdle can be cleared soon. Technological advances in the areas of data warehousing and delivery have been accomplished in many other areas and software companies are beginning to focus their attention toward the development and marketing of efficient, easy-to-use products for school use. Simultaneously, educators are becoming more aware of the application of data use for decision-making that benefits students beyond mere accountability measures such as the NCLB act. Thus, we believe the pieces are in place for information management to provide significant advances in educational effectiveness.

Information management (IM) has several useful applications for school personnel who want to use student data to improve instruction:

- By storing and retrieving varied performance data on individual students, IM technology can substantially increase the information available to professional educators.
- By easily and quickly generating standard reports on classes and schools, IM technology can provide useful information within and across classes and schools in formats that educators at all levels can quickly share and use to seek "best practice."
- By facilitating the generation of unique reports fitted to the questions of an individual educator or group, IM technology can aid in knowledge-based decisions tailored to a specific context (e.g., schools, teachers, localities).
- By making daily and annual information available to parents, mediums such as reports and web-based data presentations can increase parental involvement in everything from nightly homework to long-term educational planning.
- By making a broad range of multilevel aggregated and disaggregated data available to principals and central administrators, IM technology can provide increased opportunities to examine and understand factors affecting their schools' progress or lack thereof.
- By making available to teachers information previously obtained only through poring over hard copies of student records, IM technology can enable increased familiarity with students and help inform classroom practice.
- By making a broad range of student data easily available to teachers, IM technology can help teachers become classroom researchers.
- By storing years of students' actual work in such diverse areas as writing, mathematics, and art, IM technology has the potential to offer a comprehensive portfolio of student work and progress, and have these data available in real-time to professionals, parents, and the students themselves.

That a comprehensive solution for widespread data use in education is not yet in the market presents a unique opportunity for school stakeholders and educational researchers to help shape the future of this technology. Educational settings present a different set of challenges than those in, say, business, so software companies will need to research the field to provide tools that are appropriate for widespread use in education.

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For IM to be a truly beneficial enhancement for educational decision-making, it is important that the market for educational IM technology be driven by the needs of education, not vice-versa. Educators can help guide IM innovation by becoming discerning consumers, making educated choices in the software they buy and helping software developers learn exactly what schools need to provide the best education for our students. In the next section, we will discuss a series of issues that we believe anyone interested in the use of IM solutions might wish to consider.

IMPORTANT ISSUES IN SOFTWARE IMPLEMENTATION

Implementation of a student data analysis and presentation system can present many unforeseen challenges, so in this section we examine some topics surrounding system implementation.[1]

Issues discussed in this section include a thorough assessment of basic data needs, time to implementation, cost, choosing a vendor, and the Schools Interoperability Framework (SIF). Also addressed is the fact that many schools will be faced with the choice of whether to "build" (implement the system using district staff), "buy" (purchase a commercially available product and services), or develop a hybrid of the two.

Assessment of Data Needs

The first step toward implementing a student data analysis system should be to thoroughly assess the data, needs, and resources available to a school or district. This includes taking an exhaustive inventory of data sources, surveying analysis needs and goals, and choosing whether to implement the data system using local staff or contracted help.

Data inventory and preparation. Data considerations start with an inventory of the data currently stored—a cataloging of what data exists and where it is located. It is not uncommon for schools to have data in different locations, ranging from a main district data store, to an Excel spreadsheet on a counselor's computer, to loose papers in a teacher's files, so it is important to identify every source and location of data. This exploration necessarily interacts with the running inventory of what data will ultimately be made available for analysis.

Data "cleaning." No analysis system provides value if the underlying data are inaccurate, and school data invariably contain problems, often large and vexing ones. Therefore, schools should assess the quality of the extant data, and estimate resources required for "cleaning" the data (e.g., correcting errors, omissions, and redundancies) so that the data can be integrated. Both school districts and vendors report that one immediate benefit from implementing a data analysis system is the opportunity to clean and improve existing data sets. This often includes unanticipated benefits that emerge when

[1] A previous examination of some of these topics can be found in a publication from the National Center for Education Statistics (Clements, 2000).

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people at different levels become engaged in the cleaning and data set integration process.

Software needs. Currently available software presents a wide range of specialization. Some products offer strengths in data efficiency, others in data presentation or graphics, but no current product offers strengths in all areas. Therefore, school systems must carefully evaluate their data and analytic needs to identify appropriate software that best fits their local needs.

School data analysis systems should provide accurate and efficient storage and retrieval along with useful and intuitive presentation. Efficient storage is often accomplished through a "data warehouse," a system that integrates disconnected sets of data often found in schools into one large, seamless database. It is important that warehousing be accomplished in such a way that data retrieval is efficient. Systems that provide fantastic presentation of data with slow retrieval or cumbersome data management are not useful. The same is true of systems that provide excellent data management and access but poor data presentation. Additionally, evaluation should be done of the capacity of a data system to deliver longitudinal information as the database grows in the future to include many years of student data.

Schools should also take care to assess the types of data, presentation, and analyses that will be most helpful in educational decisions in their context. There is a paradox here, however: even well-trained professionals seldom know exactly what they will find most useful, and what they will need, until they are well into their work. Therefore, we suggest that schools cast a wide net in this assessment, involving input from many types of school personnel. Development of software for analyzing student data is in its infancy, so school systems' assessments of software needs will undoubtedly evolve, as the capabilities of various options become more widely known. We thus envision the software needs assessment as evolutionary in its own right, and we recommend that schools assess their data and software needs with an eye toward future expansion and flexibility. Failure to plan for this inevitable evolution may well result in the system offering undue constraints on data use.

What does this mean for the district or school that wishes to start in the near future? In terms of currently available software, there is no "best" program for analyzing student data because the strengths and features of current software packages vary greatly. Many programs presently in use, however, provide valuable student data analyses, and it is possible for schools to choose adequate programs today while also planning to take advantage of future technological advances.

Outside help. Some schools have relatively clean data or have the necessary personnel to quickly organize and substantially improve the quality of their data sets. Other schools/systems have data that would require a great deal of attention, and the amount of work required for data preparation and cleaning may seem intimidating. The experience of practitioners across the country indicates that the majority of schools and school systems will require substantial effort to successfully launch a practically useful, accurate

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data system. Many districts and software companies have been through this process, and it is possible to learn from the hard-won experience of others.

Third party assistance is also available in several areas. Several commercial warehousing and analysis companies offer help with the initial data inventory, helping schools identify potential data sources and aiding in merging data from dissimilar formats. Additionally, though the cost of adequate computing power and data storage capacity continues to drop dramatically, these costs may yet be seen as expensive for some schools or districts. Many commercial warehousing vendors offer affordable options for housing school data, promising fast access across the Internet.

In assessing data needs, schools and districts ultimately must make a decision as to which efforts are handled best within the organization and which must be outsourced. Our belief is that unless a district is certain that the expertise to deal with data problems quickly and efficiently exists in-house, the experience that an outside organization brings to the process is well worth the cost, especially when time and accuracy are considered.

Time to Implementation

Rapid, successful implementation is important for the long-term development of a data based decision-making climate. Experiencing early success is a correlate of long-term implementation success in a range of change efforts (Fullan & Miles, 1992), so speedy realization of at least some aspects of a useful information management system will sustain interest and improve education sooner rather than later. Many of those interviewed for this chapter stressed the importance of getting data "up and running" quickly, even if less than a full orchestra of data or reports is initially available.

The amount of time required to achieve implementation is a major consideration in choosing whether to build or buy a data system. Developed locally, implementation of a data warehouse with reporting and analysis capabilities often takes years, while most commercial vendors promise an established (i.e., running and useful) product in a matter of months. Competent commercial vendors can usually bring practical experience and specialized staffing, and thus can often get a system established and functional much faster than school personnel can when building it themselves. This is not a criticism of local school technology personnel, it merely reflects the efficiency advantages when an organization or business specializes in a particular product and set of processes.

The best route to rapid implementation is one of the important choices a school system faces in launching such a system, and it is beneficial to know that there are multiple options available to achieve this objective.

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Cost

Dollar cost structures of currently available software can be complicated and are thus difficult to accurately establish in this report. However, light can be cast on a few areas consumers should consider when evaluating costs.

For commercially available systems, the final dollar cost depends on many variables. Depending on the size of a district and the number of features chosen, the cost for a school to implement a system could range from as low as two to more than ten dollars per student per year, sometimes with a higher cost in the first year of implementation. Per-student costs are generally lower for larger numbers of students. Some vendors have noted arrangements where smaller districts share a system to take advantage of cost reductions.

Opting for external assistance with data collection and cleaning typically carries an added cost, as does opting for outside data storage. Some companies charge for consulting time spent with representatives, others build an assumed amount of consulting time into per-student pricing. In outlining a proposal, vendors may package various options together for one cost, or many of these features and others (e.g., access to state standards information) may be included in the basic system. Whether bundled together, chosen separately, or included in the basic system, a hardly surprising general rule is that more features translate to higher costs.

Costs for implementing a locally developed system are typically more difficult to evaluate. Such costs include deployment of hardware and other materials, along with salaries and benefits for local employees used in the project. Not only must local talent be paid (a cash cost), but the time they spend developing, debugging, and implementing the product is time that could be spent on other projects (an ongoing opportunity cost). These other projects will then either be ignored or pursued with other staff, both at some real but typically not quantified cost. Data cleaning presents other cost issues. In our interviews with local educators and national product developers, we consistently heard that school data is almost always "messier" than school personnel anticipate. Schools planning local implementation should fully assess the quality of their data and the ability of the personnel structure to handle this project in the short and long terms. Additionally, there is no guarantee that the locally developed product will initially work in the ways intended, so development costs past initial implementation generally serve to further complicate the picture. Consequently, a clear understanding of the school organization and issues surrounding implementation of such a system is vital to accurately evaluate the cost of local development.

Time must be evaluated as a cost in an additional way. Schools are about the work of education, and in education, lost time carries costs. When contrasting a "less expensive" locally-built data tool taking two years to develop and implement with a "higher cost" commercially-built tool taking three months to implement, one well might conclude that the locally-built product is "cheaper." But does the lost opportunity to better diagnose and educate children justify the dollar savings? Each day and year that data goes

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unused is a lost opportunity to better diagnose and educate children. In evaluating costs, school entities should include opportunity costs.

Choosing a Vendor

Should a district wish to purchase a commercially available student data and analysis system, there are many products from which to choose. Software companies focus on different strengths, and no company currently offers a software package that is strong in every area. Today there is no "best product," so choosing a vendor entails finding the best fit for the local district's or school's needs.

In choosing a vendor, school systems first should evaluate the range of services they wish to purchase. Some vendors offer services that schools may find useful, beyond delivery of data. For instance, a school in need of help with educational improvement, or a school in need of professional development for data use, might do well to contract with companies that provide these added services.

Schools and districts would be well advised to contact other schools using the software, query them thoroughly, and visit as many as possible to get practical feedback on the types of products and levels of service each vendor offers. Schools' own negotiation experience with the vendor may be significant. Does the company return calls in a timely manner? Is the company forthright and responsive to information requests? Any prospective purchaser would be well advised to establish multiple relationships at the prospective company (e.g., both a salesperson and a relatively senior executive or technical specialist). This not only helps school personnel learn about the company, but will provide multiple routes to resolution should problems arise.

Finally, there are issues related to the long-term viability of various companies. In a start-up industry, no one can be sure which companies will stand the test of time. One possible guide is the establishment of industry standards, currently being explored through the Schools Interoperability Framework, discussed in the next section.

Schools Interoperability Framework

The Schools Interoperability Framework (SIF) is a collaboration of school data stakeholders that set data exchange standards to enable software packages to communicate without further software intervention. The SIF website (www.sifinfo.org) identifies SIF as "an industry initiative to develop an open specification for ensuring that K-12 instructional and administrative software applications work together more effectively."

SIF came into existence because stakeholders in the technology industry recognized that school options for software were growing rapidly, and that if no standards were set for inter-software communication, schools could potentially be handicapped in their options for improving and upgrading their data capabilities over time. At the time SIF was formed, school personnel were experiencing such problems as redundant data entry, loss of data, and an increasing amount of time spent on data entry and management.

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Without industry standards to ensure communication, it is feared that school systems' ability to send and receive data efficiently (e.g., to and from state departments) could be greatly hampered. Consequently, SIF members have engaged in ongoing work to establish industry standards in defining formats for shared data, naming conventions, and rules of interaction among software applications (www.sifinfo.org). The current list of SIF members includes educational technology companies, school districts, federal and state government offices, and research organizations.

The SIF initiative is an ongoing project. Accomplishments include the development of a Zone Integration Server that enables software programs to communicate with one another, and the establishment of definitions and objects for commonly used student data (e.g., name, address, gender), and most recently, the launch of the SIF Compliance program in May 2003. The SIF Compliance program allows for applications to be tested by a third party validation system to ensure both schools and vendors that applications developed using the SIF standard will work together. More details, including the list of SIF-compliant applications, can be found at www.opengroup.org/sif/cert/cert_prodlist.tpl. Ongoing efforts include establishing forms and definitions for "learning data" such as grades and assessment information. SIF is also working with a number of states and the U.S. Department of Education to enable SIF to support district-to-state reporting in support of No Child Left Behind (NCLB).

Vendors hold a wide range of attitudes toward SIF compliance. Many are solidly supportive of the process, and some have already completed SIF certification for their products. Others express caution due to the cost of participation.[2] Other personnel express apprehension as to the ultimate value of SIF standards. Some companies report waiting to pursue SIF standards until there is more demand from their clients. In addition, some representatives of companies not listed as SIF-certified maintain that although their company has not yet participated in SIF certification, their products are nonetheless compliant with SIF standards.

The impact SIF holds for schools in the process of buying software is the assurance that SIF-compliant applications will be able to communicate with each other. No school wishes to be in the position of depending on a software package that later proves to be incompatible with other software. Consequently, if SIF definitions become the industry standard, buying an application from a company that does not place emphasis on SIF compliance could place a school or system in the awkward position of having to change technologies.

In general, school personnel should take care to protect their software investment against future isolation by ensuring that this product can communicate with other products. SIF represents a promising initiative, and SIF standards represent a reasonable starting point in evaluating software interaction. In evaluating software, school personnel

[2] As of this writing, initial SIF certification costs are $35,000 for a non-SIF member (www.opengroup.org/sif/cert/docs/fees.htm).

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should thoroughly question software personnel about knowledge and involvement with SIF, along with plans of how their software will grow to gain compliance.[3]

WHAT SHOULD GOOD SOFTWARE FOR STUDENT DATA ANALYSIS LOOK LIKE?

The most efficient software for student data analysis would be an intuitive, user-friendly package that provides comprehensive, error-free data to users at every level. In this section, we describe software features that should be present in such a package. Table 1 provides a synopsis of our narrative.

Table 1. Important Features of a Student Data Analysis System

User Friendliness
Software is intuitive and easy to use.
Software requires little training.
Presentation is familiar to user.
Access speed is fast and efficient.

User Features
Comprehensive query tools available for every level of user.
Flexible drill-down capability from any form of data aggregation.
Data can be accessed from anywhere.

Information Access
Multiple ways to access information.
Varied methods of representing information (e.g., tables, graphs).
Wide range of data available for analysis.
Interface provides immediate access to relevant information.
Pre-formatted reports are clear, varied, relevant, and comprehensive.
Longitudinal presentation of data available at every user level.

Creating and Sustaining Quality Data
Provides capacity to enable clean data.
Company accepts responsibility to facilitate data process with schools.
System allows for expansion past initial implementation.
System provides proper security for data transmission.
Integration of different areas of information is seamless to the user.
Software accepts many common data formats.

Additional Features
Online student work samples available.
Software exports into common programs.
Users can access electronic discussion groups.
Easy access to learning standards information.
Software offers capacity to link individual teacher data to student data.

[3] School personnel may access a full set of questions regarding SIF compliance, also suitable for use in an RFP, on the SIF website at www.sifinfo.org/getrfp.html.

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User Friendliness

To provide maximum value, software for student data analysis must be easily accessible by all levels of educators. We believe that educators will have little tolerance for programs that are limiting, frustrating, or esoteric, so the best product will be a "user friendly" one that intuitively provides a set of data analyses to the user. A program with an intuitive, easy-to-use interface will serve to promote data access and increase educator desire to pursue the substantial range of information available in student data.

Given the time demands educators face, and the fact that many are not computer experts, it is logical to assume that teachers and other school professionals will make more and better use of analytic software if it is presented in a familiar form that requires little or no training. For example, the growing use of the Internet has made many users comfortable with web-form elements (e.g., links, check boxes, and pull-down menus common to sites such as Amazon.com). User-friendly features such as these entail nominal training time for users and serve to minimize frustration.

School data warehouses are large and will be accessed by many users, even in small schools or districts. These conditions raise the issue of the speed at which the system can access data and return answers. It is important that computer response time is rapid, enabling deeper data querying. Slow response time is likely to cause user frustration and almost certainly reduce data use.

User Features

To encourage and facilitate data use, it is important that user features are flexible, allowing for data access in a variety of forms.

Users should be able to explore the data and answer their own questions, as opposed to relying entirely upon distributed information. Customized, ad-hoc data requests are facilitated through the use of a "query tool." Although query tools often exist for advanced users, or "power users," it is equally important that software offer query tools for less sophisticated users. Query tools should be simple to use and require little training, incorporating user-friendly features such as those described previously. Query tools should also be unrestrictive, allowing access to a wide range of data and the ability to provide simultaneous analysis of many variables.

Broad "drill-down" capability (e.g., the ability to query a school level finding to efficiently examine a subset of data at a grade, classroom, or student level) is a desirable feature that provides maximum user ease and flexibility. Drill-down functions should be available from any point in the program; users should be able to click on graphs, tables, or any form of disaggregation to gain more granular information, reaching as far down as the student level.

Educators also must be able to access such software by Internet from home or anywhere else they choose to work. Teachers and other education professionals often work outside school walls, and it is important to provide data access whenever or wherever they choose to work.

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Information Access

Access to student information should be varied and comprehensive to allow for thorough inquiry. Users are limited when the information available does not answer all of their questions; further, users will grow in their analytic abilities only if provided with a wide range of information fully applicable to their situation. Therefore, the user should be provided with wide-ranging means of accessing information, across a range of complexities that include every level of user, and with many forms to represent this information (e.g., a variety of graphs and tables). Items available for any analysis should never leave the user wanting more.

When the user logs on, the interface should provide quick access to information through a variety of methods. Such access may involve quick snapshots of information, the aforementioned user query tool, and pre-formatted reports on important topics. Information available in pre-formatted reports should be concise, relevant, and comprehensive. Such reports necessarily must be constructed through a process of thorough consultation with a diversity of school personnel.

Students' education takes place over a number of years, so the range of data available must also allow for longitudinal presentation over all periods of available data. Longitudinal access enables the user to examine trends of schools, classrooms, and students over time. Presentation and analysis of longitudinal data should be limited only by the available data, not by the software itself.

Creating and Sustaining Quality Data

The presentation and quality of data are inextricably connected. Regardless of the ease and breadth of data access, any analysis is worthwhile only to the extent that the underlying data are worthwhile. Therefore, it is important that systems for analyzing student data are built to provide error-free, secure data with the flexibility to accommodate future needs.

Many school systems will require assistance in building data sets that lead to educational improvement. Any company producing such a program should be prepared to assist schools and districts with the problems inherent in school data, whether this be through the company itself or a partner. Such assistance should include assistance with identification of proper data elements to include in the database, data collection guidance, and help with correcting data errors and inconsistencies.

Since school data needs will change over time, it is important that the data warehouse and presentation program allow for expansion beyond the initial implementation. Any implementation of a data system necessarily imposes boundaries on the extent of data use. If a system cannot change as school data needs change, the system will become a constraint upon, rather than a facilitator of, educational improvement.

Nearly all systems allow access from a distance, but such access carries inherent security risks that should be of paramount importance. It is necessary that programs offering such access provide airtight security for transmitting student data. School personnel

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and software vendors are aware of these issues and are constantly improving policies for protecting privacy.

Data warehouses by definition integrate many disparate forms of information (e.g., attendance, demographic information, test scores). Integration of these areas should be seamless to the user; the more transparent this integration is, the easier navigation will be.

The capacity to use many common formats (e.g., ASCII, XML, Excel) to import and export data is also important. School personnel will find restrictive formats limiting when data is to be transmitted outside the system, as when preparing NCLB data for state agencies. Restrictive formats will also be cumbersome when data is to be imported into the warehouse. XML in particular is becoming a popular format for data exchange, and many developers have adopted XML as a standard.

Additional Features

Other desirable features include the following:

- Online student work samples: school personnel should be able to access not only numeric data on a student, but also see annual samples of each student's "authentic" work online.
- The ability to export graphs or other results into common programs such as Microsoft Word or Adobe Acrobat.
- Electronic discussion groups or "message boards" where users from any location can discuss issues relevant to the software. Yearly or bi-yearly user group meetings are also desirable.
- Easy access to the learning standards that drive local or state assessments.
- The capacity to link a teacher's own student data to data accessed by the system. For example, a teacher might wish to correlate in-class grades with, say, assessment results from a state test.

In the next section, we offer reviews of commercially available software for analyzing extant student data. The authors do not endorse any one software option, and believe that each has one or more features that might make it attractive to a district with needs well matched to the specific software strengths.

SOFTWARE REVIEWS

Sampling Methods

A major goal of the authors in preparing this report is to provide a summary of the software options schools have for analyzing and disaggregating extant student data. Software was included if it enabled many different levels of school personnel to analyze existing student data for achievement purposes (i.e., any data that is collected and stored by the

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school, such as achievement tests, demographic data, and portfolios). Software that allowed only district personnel to view student information was not included, nor was software that accessed only school management issues (e.g., attendance, absences) or software that required ongoing teacher data entry (e.g., grade books, palm pilots, data scanning).

Commercially available software was identified through various means, including literature searches, web searches, and personal conversations with individuals familiar with school software. Because of the dearth of summaries of school software, much of our data were collected by directly contacting people in the industry and slowly building a network of information. This "snowball" strategy was time-consuming, but we believe that it has produced a reasonably comprehensive summary of commercially available software that is usable and useful in warehousing and analyzing student data.[4]

In evaluating the software, we contacted companies and were put in touch with representatives, usually sales or management personnel, who were knowledgeable about the available software packages. During these interviews and subsequent software demonstrations, the authors gathered information using a semi-structured interview protocol. Companies were included in this review only if our contacts were able to provide an interactive demonstration of the software. Demonstrations were conducted over the Internet during a phone conversation with company representatives so that our lack of training in the use of the specific software was not a limitation. In several cases, a demonstration website was also made available to us so we could explore the software on our own for purposes of more detailed product examination.

In contrast, our process of identification of locally developed software was necessarily not comprehensive, as a large number of local initiatives exist. Instead, we contacted school districts in Houston, Texas, Cleveland, Ohio, and Broward County, Florida. These districts were chosen because they have received substantial publicity regarding their locally developed systems. We were unable to get Internet demonstrations of these programs, so we will not present reviews of their performance. Rather, we will discuss these initiatives in terms of interviews conducted with school personnel.

Software Not Included

We sought to examine software that enabled teachers and other school personnel to analyze existing student data to improve teaching and achievement. Consequently, there is a wide variety of quality school data software that we did not review, such as software packages that serve only as student information systems, software used for administrative student management, software developed to generate assessment data, or software that requires data entry by teachers. Examples of such software packages include PowerSchool from Apple, a student data management system that also facilitates parental

[4] Although employing a thorough process, it is possible that the team has missed some vendors currently on the market and that others have entered this rapidly changing market since this report was written. The authors would be most appreciative of any information on additional products that are, or come to be, on the market.

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communication, as well as Renaissance Learning's tools for analyzing and creating curriculum-based assessment data.

There are a small number of software companies with products we were unable to review for this report, but that provide analysis of student data. We note these companies in Appendix A in order to provide as thorough a list of software as possible. It is our hope that subsequent updates of our work will include these products.

Limitations

The companies themselves provided the data for these reviews, and demonstrations worked from company-controlled data sets. There are many facets of software that are best evaluated through using the software in a practical local setting (e.g. response time, database size, querying efficiency), but we were not able to undertake a data collection of that magnitude or test all products against a single school system's data base.

Overview of Reviews

Before presenting the reviews, we make some general comments about the programs as a group.

The aims and features of software for analyzing student data are varied, and each company has chosen one or two aspects of student data on which to concentrate their programming efforts. Companies may choose to focus on providing reports, easy data access, or assessment data, to name a few. No one piece of software accomplishes everything, and some features are more common than others. For instance, most companies offer pre-formatted reports of student data that can be generated with a mouse click. Fewer companies offer stored queries, where the user can perform a customized query of the data, then save that query for use by themselves or another user. Only two companies reviewed here offer storage and retrieval of student work samples, or electronically accessible portfolios of student work.

These programs do share several features, features that a school should expect in buying software for student data management. All of the programs reviewed are web-based, and thus offer user access from any Internet connection.[5] All programs offer at least descriptive analyses (e.g., means of different groups and sub-groups), and all offer the capacity to produce reports based on the disaggregations mandated by the NCLB legislation. All offer some form of ongoing technical support, and all companies are at least aware of the evolving Schools Interoperability Framework (SIF).

Beyond these commonalities, schools and school systems must choose software based on specific software strengths. We anticipate that as the field moves toward scale, schools will be able to choose from more comprehensive programs. At present, however, it is important that schools carefully evaluate present and future software needs, resources, and available software options, choosing software matched to local needs.

[5] Note, however, that many implementations of QSP utilize the desktop version, which is PC-based.

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Table 2. Characteristics of Commercially Available Software

Software and Company	Account from SchoolNet	Data Miner from Chancery	Data Point from NSSE	Ease-e from TetraData	EDsmart	eScholar	QSP from CRESST
Company Focus	Educational Technology	Student Information Systems	Educational Research	Educational Technology	Educational Research	Data Warehousing	Educational Research
Version	4.0	4.1	n/a	4.5	3.2	5.0	4.3
Pre-formatted reports	x	x		x	x	x	x
Query tool for less-advanced users	x		x	x	x		x
Stored queries		x	x	x	x	x	x
Online student work samples			x				x
User discussion boards or user meetings	x			x	x	x	x
Accepts data formats in addition to ASCII	x	x		x	x	x	
Variable set customized to fit school needs		x	x	x	x		x
Company will house data	x		x	x	x	x	
School may house data	x	x		x	x	x	x
Company helps collect data	x	x	x	x	x	x	
Reports SIF compliance	x	x		x	x	x	
SIF-certified	x	x		x		x	
Number of districts in use	40	83	15	464	27	750	100

In the following narrative, programs are reviewed in alphabetical order. Each review starts with an overview of the company and the focus of their software. Discussion then shifts to two sub-sections on user functionality: the availability of pre-formatted reports (standard reports that are available for review with one click), and query tools (the interface in which the user is able to access the data in ad-hoc fashion). The fourth sub-section addresses the software's compatibility with SIF, followed by a sub-section discussing features that were not included under the previous headings. Table 2 provides a side-by-side view of some different features available in the programs reviewed for this report, and Appendix B provides "screen shots," or examples of the look and feel of reviewed software. Additionally, since software features and functions change rapidly, we are maintaining a website that contains updates of product reviews: www.csos.jhu.edu/systemics/datause.htm. The Software Reviews section concludes with a segment discussing locally developed warehousing/reporting software.

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Table 2 (cont'd). Characteristics of Commercially Available Software

Software and Company	Sagebrush Analytics, powered by Swift-Knowledge	SAMS from Executive Intelligence	Scholar Suite from SCHOLARinc.	Socrates Data System from CRM	STARS from SchoolCity	Virtual EDucation from Edmin
Company Focus	Data Analysis & Reporting	Educational Technology	Management of Assessment Data	Educational Research	Educational Technology	Learning Management
Version	5.1	3.4	2.0	2.2	2.6	5.5
Pre-formatted reports	x	x		x	x	
Query tool for less-advanced users	x	x			x	x
Stored queries	x		x	x		x
Online student work samples						x
User discussion boards or user meetings		x		x		x
Accepts data formats in addition to ASCII	x	x		x	x	x
Variable set customized to fit school needs	x	x		x	x	x
Company will house data	x	x	x	x	x	x
School may house data	x			x	x	x
Company helps collect data	x	x		x	x	x
Reports SIF compliance		x	x			x
SIF-certified						
Number of districts in use	35	20	15	92	28	110

Account from SchoolNet

SchoolNet (www.schoolnet.com) is a company describing itself as providing educational technology designed to help schools meet their educational goals. Three modules are available with SchoolNet: Account, which permits analysis of student data; Align, an instructional management tool; and Outreach, a school district portal designed to facilitate communication between schools, teachers, and the public (e.g., parents, community leaders). To analyze student data, SchoolNet offers the Account module, focusing on ease of analysis and presentation. Schools can opt to purchase only Account; they need not buy all three of the SchoolNet modules. In September 2003, we reviewed Account, Version 4.0.

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Data management. Once a school contracts with SchoolNet, representatives meet with school personnel to decide the most practical way to handle the school's or district's data. In choosing which variables to include in the SchoolNet database, schools may choose from a standard set of variables offered by SchoolNet. SchoolNet personnel report that although this variable set meets the needs of most schools, custom development is available in many cases for schools that wish to track data items not included in the standard set. Schools then gather and clean their data to be sent to SchoolNet to create the school's database; SchoolNet personnel will work with district contact people on this process if needed. SchoolNet accepts many common data formats. Upon receiving the data, SchoolNet personnel execute an automated cleaning process and notify the school if there are changes that should be made. Schools then continue to maintain their Student Information System (SIS) and update their SchoolNet database from the SIS as often as desired; in fact, some districts execute nightly automated updates. The school can opt to house the database on its own servers or on SchoolNet servers.

Pre-formatted reports. Account features a set of pre-formatted reports that come with the implementation of the software, and SchoolNet representatives work with school personnel to decide which of these reports to make available for the school/district. Additional reports can be defined by the school and added later, but this must be done through SchoolNet personnel. These reports also feature broad drill-down capabilities; the user can click on any summary in the report and get information about the individual students who make up that particular summary. The drill-down capacity enables users to look at any available data on the individual students, including historical data as far back as the database permits. All reports can be printed directly from Account or copied and inserted into documents.

Included in the standard set of reports is a set called the "AYP Stoplight Reports," which provides information on Adequate Yearly Progress (AYP) measures from the NCLB legislation. In these reports, groups of students who met state AYP benchmarks are color-coded in green (passing). Students not meeting AYP benchmarks are color-coded in yellow (near passing) and red (failing), based on a "Student Proficiency Ranking Index" developed by SchoolNet personnel. As with other reports, the user can click into the AYP reports to get more information on the individual students within the three groups.

Query tool. The user query tool in Account is termed a "custom report builder," providing the means for users to explore data in an ad-hoc fashion and build reports similar in appearance to the pre-formatted reports. The query tool is easy to use and is designed for users of all levels of technical expertise, employing user-friendly check boxes, pull-down menus, and other familiar web-form elements. The tool provides access to the entire range of the student database and allows users to browse through student data with few limitations. Reports built through the query tool also feature clear presentation and drill-down capabilities found in pre-formatted reports. Users can run more complicated analyses through a function in which data is exported from Account to Excel, SPSS, or another package of the user's choice. The Align module for instructional management

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allows more detailed assessment queries than does the Account module, but schools must have purchased both modules to enable this sort of access.

SIF. SchoolNet is a member of SIF. Representatives report that SchoolNet software is SIF-compliant and SIF-certified.

Other. SchoolNet has available electronic discussion boards for users through the Outreach component of their software. These discussion boards are available within particular districts, although SchoolNet personnel are developing the capability to provide discussions between all SchoolNet users.

Data Miner from Chancery

Chancery (www.chancery.com) is a company with a focus on school Student Information Systems, offering the Chancery Student Management System (Chancery SMS) for this purpose. As a service to schools, Chancery offers a reporting product called Data Miner that allows ad-hoc querying of information within Chancery SMS. In October 2003, we reviewed Data Miner, Version 2.0, working with Chancery SMS, Version 4.1.

Data management. Chancery SMS is a Student Information System (SIS), so the involvement of Chancery personnel in data preparation and management is necessarily very involved. In the initial stages of the relationship, Chancery representatives visit the district and conduct a data needs analysis, spending a few days meeting with district decision-makers in a data planning process. Once this process is completed, Chancery representatives help install the Chancery software on school computers and help school personnel get Chancery SMS up and running. Since Chancery is an SIS, schools must house and manage the data on school computers.

Pre-formatted reports. Chancery offers a set of pre-formatted reports with Chancery SMS. About 50 reports come with the implementation of the software, and schools can request that custom reports be added. Most pre-formatted reports are easily accessible through a set of user-friendly links on the "dashboard," (the user's initial screen), and some are also available through a query screen, which requires some brief specification. These reports contain a variety of information at the district, school, and student level and are presented in printable and exportable graphs or tables. Chancery personnel report that schools can request "drill-down" capacity in some reports, the capacity to click on an area of a graph or table and gain more information about the underlying students.

Query tool. The Data Miner query tool included with Chancery SMS is aimed at more advanced users. Chancery personnel point out that since the focus of Chancery software is on student data management, there has not been a great focus on development of presentation tools. As a service, however, Chancery personnel developed the Data Miner to handle queries often performed at the district level. This query tool is powerful, accessing any data in the SIS, and could be used by lower-level users after some training. The final presentation of the data is good, with access to tables and graphs, along with a drill-down capacity to enable the user to explore subgroups of students. Reports formed

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by the query tool can be exported to Excel, but the user cannot print directly from the Data Miner. Users can store queries for later use.

SIF. Chancery is a member of SIF. Chancery personnel report Chancery SMS tools are SIF-compliant; they are not yet listed as SIF-certified.

Other. Through the data available in Chancery SMS, the Data Miner has the capability to link individual teacher-collected data, such as grades and class percentages, to other student data, such as assessments.

DataPoint from NSSE

The National Study of School Evaluation (www.nsse.org) is a non-profit educational research organization that promotes school improvement planning, currently focusing on data based decision-making. To perform data analysis, NSSE[6] offers the DataPoint Web-based Software for Knowledge Management and Data-Driven School Improvement Planning software package (www.nsse.org/datapoint/index.cfm). DataPoint is integrated with the NSSE school improvement plan, and offers an improvement planning component in addition to the school data component. In September 2003, we reviewed DataPoint (no version number available).

Data management. Since the focus of NSSE's programs is to help schools build capacity to use data, the data collection and management process intentionally involves more school responsibility than that required by most other companies. In the early stages of data gathering, NSSE representatives work with school personnel to identify data components for inclusion in DataPoint. Data components include not only the traditional student measures, but also measures of organizational effectiveness and measures pertaining to teaching, where available. School personnel then gather data into ASCII format to be loaded into the school's DataPoint database. Schools are responsible for maintaining the database from this point forward. NSSE representatives report heavy involvement with school personnel during the identification and gathering processes and initial data management because NSSE personnel believe that working closely with school personnel during the initial startup phases provides better preparation for long-term, efficient data use. After the initial phases, data input into DataPoint can be done by anyone with proper permissions. For instance, designated district personnel might input district data accessed by everyone, a particular school might input data accessed only by personnel at that school, and a teacher might have access to input his or her own data to be used only by him/herself. User-inputted data is linked to the larger, shared school database, although there currently is not full integration between user-inputted data and the common school data.

Pre-formatted reports. Pre-formatted reports are not available in the initial implementation of DataPoint, but are available as created by school personnel. After the

[6] Note that the National Study of School Evaluation (NSSE) is a separate organization from the National Society for the Study of Education (also NSSE). Both are not-for-profit organizations.

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DataPoint product is running, permitted school personnel can run queries and save these queries as reports to be available to all users.

Query tool. The query tools in DataPoint allow the user to build student data reports in many graphic or tabular forms, disaggregated by a variety of demographic variables or for individual students or groups of students. A strength of the DataPoint software is the guidance offered the user through the querying process; the depth of this guidance also creates many steps in creating a data query. An interesting querying option is the Student Datacard Report, which presents all available data for an individual student. This report can be written to one document and printed, or viewed through the software, grouping common data (e.g., achievement measures, student characteristics) into tables. A recent addition to the DataPoint query tools is the Student Data Analyzer, which allows for statistical comparison of disaggregated results.

SIF. NSSE personnel report that the DataPoint software is not SIF-compliant.

Other. NSSE representatives report that the capacity to scan and store student work samples is offered in DataPoint, although this capacity is not commonly used. NSSE representatives also report an emphasis on the use of data outside the traditional student measures of demographics and assessment results. These data include qualitative and quantitative measures of school and teacher effectiveness and student performance, often including data gathered through surveys, interviews, and observation. As part of the NSSE school improvement plan, NSSE representatives work with school personnel to collect and use these data to efficiently inform school practice.

Ease-e from TetraData

TetraData Corporation (www.tetradata.com) is a company that specializes in software for education, offering the Ease-e Analysis Suite for analyzing student data. In September 2003, we reviewed Ease-e, Version 4.5.

Data management. Before contracting with TetraData, schools may opt for a pre-contract service, where TetraData personnel consult with school personnel to help identify which paths toward data use will best help that school. After contracting with TetraData, a "data discovery process" begins, where TetraData personnel work closely with school personnel in identifying, specifying, and gathering data. TetraData personnel describe involvement in this process as ongoing, since school databases often evolve as schools make use of data and uncover new needs. Data are sent in any form to TetraData, where data cleaning is done during the building of the school's database. Schools continue to maintain the school Student Information System, updating the TetraData database as desired. Schools may choose whether to house and manage the data on local servers or TetraData servers.

Pre-formatted reports. The Ease-e Suite has a set of pre-formatted reports available. The Ease-e reports are created by TetraData personnel after consultation with school personnel, and extra reports can be requested later by school personnel and added by TetraData staff. These reports contain a variety of cross-sectional and longitudinal in-

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formation, typically at the district or school levels. Information contained in the reports is clearly presented and easy to understand. These reports can be printed from the software or copied and pasted into documents or presentations (e.g., Microsoft Word or PowerPoint).

Query tool. The Ease-e suite offers two forms of querying: the Classroom Analyzer, which is less flexible but less complicated, and the Data Analyzer, a more powerful tool. Both tools are easy to operate by any level of user, featuring an intuitive, web-style interface. The Classroom Analyzer is intended to be used for commonly-executed queries and thus offers a more limited choice of display options. This tool is designed to guide the user through a simple five-step query process, and TetraData personnel report this tool to be very popular. The Data Analyzer allows access to the full set of variables in the database, along with a flexible set of options for output and analysis. Users can display data longitudinally over any years available in the data set and have "drill-down" access, or the capacity to click on sets of aggregated information to find out more about the underlying students. Output from the Data Analyzer is printable and exportable to Excel and other software packages, and statistical analyses as advanced as linear regression are available. Users can also store queries from the Data Analyzer for later use.

SIF. TetraData is a member of SIF and reports that the Ease-e components are SIF-compliant. Ease-e is listed as SIF-certified in the SIF Certification Registry.

Other. Ease-e users also have access to an electronic discussion board that enables them to communicate with other Ease-e users.

EDsmart

EDsmart (www.edsmartinc.com) is a company that describes itself as founded on the belief that knowledge of the relationships between educational outcomes is a key to improving student achievement. The primary focus of the company is on data analysis and providing schools with ongoing help in formulating analysis questions, creating reports, and other tasks related to data inquiry. Accordingly, EDsmart seeks to provide data based technology for school improvement through its EDexplore software. EDexplore is packaged with a School Improvement Reports module and with EDdiscover, a new data aggregation tool. In September 2003, we reviewed Edexplore, Version 3.2, with Versions 1.0 of the reports module and of EDdiscover.

Data management. Although not a data warehousing company, EDsmart is attentive to data warehousing efficiency, implementing a data model that EDsmart personnel assert is very effective at customizing a data warehouse for each school. EDsmart personnel work with schools during the data collection process, beginning with the "data inventory," a structured questionnaire designed to help schools identify every possible data source that they may have available. During the data identification and collection process, EDsmart personnel help school personnel decide which variables will go into the school's database. When the data are ready, school personnel send the data in any electronic format to EDsmart to be entered into the school's database. EDsmart personnel

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execute a data cleaning process that is both automated and manual, then notify the school of changes necessary in the data. School personnel continue to maintain the school's Student Information System and send periodic data updates to EDsmart, typically about four times per year. In most situations, EDsmart houses and maintains the data warehouse.

Pre-formatted reports. The report module with EDexplore is very flexible, offering pre-formatted reports with the attractive feature of "drilling into" the reports (i.e., in some instances, users can click on areas of the report and gain more specific information about the selected area). For example, if a report lists students not proficient on a particular math assessment, the user can click on a student's name in the report and gain more information about that particular student. In addition, EDexplore comes with reports specific to the NCLB requirements.

Query tool. The EDexplore query tool is intended for advanced users and thus requires some training and familiarity in order for users to comfortably use it. This tool is flexible and offers many different forms of disaggregation and analysis. Users with proper access can store EDexplore queries in the form of a report and make these reports available for other groups of users. EDsmart has recently released the EDdiscover query tool, aimed at administrators, and offering easier access than with the EDexplore query tool. EDsmart personnel report that after a half day of training, users are easily able to navigate through EDdiscover. The EDdiscover tool operates using "slicers," or a list of variables that users can drag and drop to build a query. Results produced by the EDdiscover software typically display both tables and graphics, which are clear and easy to understand. Users can also drill through these results for further ad-hoc exploration.

SIF. EDsmart personnel report that EDexplore is SIF compliant and will pursue SIF certification through a partnership with eScholar (see below).

Other. EDsmart offers electronic user discussion groups, along with periodic user meetings, enabling users to exchange ideas about data analysis with EDsmart software. EDsmart also offers fee-based data mining consulting for schools that wish to use the procedure to probe their data further. Additionally, EDsmart features the capability to link teacher grade book information to the common core of student data, on a custom basis.

In September 2003, EDsmart announced a joint developing and marketing partnership with eScholar. This partnership offers schools that contract with EDsmart the data presentation and school improvement strengths of EDsmart, along with the data warehousing strengths offered by eScholar.

eScholar

eScholar (www.escholar.com) is a company with the declared focus of bringing data warehouse solutions to education. eScholar personnel report that the company does not seek to be a comprehensive solution for aggregating, disaggregating, and presenting student data, but seeks to provide schools with a sound data warehousing system that most efficiently integrates all of a school's data. Still, eScholar does provide data analysis and

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reporting tools with their warehouse. In September 2003, we reviewed eScholar, Version 5.0, with the eScholar Vista Express and Vista Advanced reporting tools.

Data management. With a focus on providing the best data warehousing solution possible for schools, eScholar is necessarily concerned with providing a very efficient "data model" (i.e., the setup for data access), and reports extensive, ongoing research into identifying and updating a data model that works best for integrating educational data. eScholar personnel initially work with schools through a "readiness workshop" that takes place before a school chooses to contract with eScholar. The readiness workshop is designed to explore all the data needs a school may have and to outline clearly the resources a school must provide (e.g., cost, personnel, data). Once a school chooses eScholar, any further data identification is done with the school. Data collection begins (schools can contract with eScholar to help with data collection), then the school sends their data in any electronic form to eScholar to create the school's eScholar data warehouse. Extensive cleaning and analysis is done at eScholar and the school is notified of any mistakes or changes that might affect this data. Schools can contract with eScholar to house and manage the data warehouse, with the school providing periodic updates; alternately, schools can choose to house the data themselves. Because of their commitment to their data model, eScholar specifies a set of variables schools can choose to include in their data warehouse. Although eScholar personnel report offering nearly any data choice that schools ask to include, it is still possible that a school might ask for inclusion of a variable not on eScholar's template. eScholar personnel report a positive response to most requests, noting that improving options for one school ultimately improves data options for all eScholar customers.

Pre-formatted reports. To produce pre-formatted reports, eScholar offers the newly released Vista Express reporting tool. Reports from Vista Express are not purely pre-formatted, as the Vista Express tool requires a small amount of specification by the user to define the sample. However, sample filtering is minimal and uses pull-down menus that require no training. Reports produced by Vista Express typically contain a table and graph, are clear and easy to read, and can easily be printed or saved. In certain areas, the reports feature drill-down capabilities to explore students within a specific aggregation. Content offered in these reports is typically aimed at administrators, but teachers also will find many Vista Express reports useful. One feature particularly attractive for teachers is the "student profile," which displays student history data such as test scores and grades, typically found in the student's permanent record.

Query tool. eScholar offers a query tool called Vista Advanced, designed for advanced data users. The Vista Advanced query tool is business-like in appearance and will provide the flexibility and querying power desired by advanced users, but is not likely to be popular with less-advanced users. With a stated focus toward data warehousing efficiency, eScholar management has chosen to focus resources on data efficiency and on partnering with other software companies offering tools designed for presentation. Thus, districts or schools that wish to provide data access for less-advanced users can take advantage of partnerships held by eScholar with companies such as EDsmart and SchoolNet that offer more user-friendly presentation products.

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SIF. eScholar is a SIF member and representatives report heavy involvement with the ongoing development of SIF. EScholar software is SIF-compliant and is listed as SIF-certified in the SIF Certification Registry.

Other. eScholar offers a second warehousing option called Violet, which focuses entirely on reporting for NCLB requirements. Schools can contract to run eScholar, a larger tool that will include NCLB reporting variables along with all other school data, or Violet, a smaller tool that includes only NCLB variables.

In September 2003, eScholar announced a joint developing and marketing partnership with EDsmart. This partnership merges the data warehousing strengths offered by eScholar with the data presentation and school improvement strengths of EDsmart.

QSP from CRESST

The National Center for Research on Evaluation, Standards, and Student Testing (CRESST, www.cse.ucla.edu) is an educational research organization concentrating on assessment issues and their application to educational improvement. Through this mission, CRESST produces many research products, one of which is the Quality School Portfolio (QSP). CRESST offers both a PC-based and a web-based version of QSP. Interested users can download the desktop version of QSP free at qsp.cse.ucla.edu. Access to the web version is given through CRESST, and requires participation in a training program, along with optional participation in a research study. The QSP software consists of two modules: the Data Manager, with which users can manage and aggregate student data, and the Resource Kit, which provides tools for collecting data to assess areas such as Curriculum and Instruction and Parent Involvement. In September 2003, we reviewed QSP, Web Version 4.3; earlier, we had reviewed the currently available desktop product, Version 2.0. The programs carry many similarities, so the following discussion will describe features common to both QSP products, noting unique characteristics of either the web or desktop version.

Data management. QSP is available free of charge. However, CRESST does not venture to offer any data support in terms of cleaning, housing, or incorporating data. In order to employ the desktop version of QSP, users visit the website and download QSP with instructions for installation. Web users get similar instructions through CRESST representatives. For both versions, users then follow data formatting instructions to read student data into QSP and are responsible for data preparation, cleaning, and accuracy.

Pre-formatted reports. Pre-formatted reports are available in the desktop version of QSP, but not the web version. These reports offer various disaggregations describing school makeup and school performance measures. They require a small amount of specification by the user, to identify the type of requested report and the variables to include in the report, but are nonetheless easy to access and produce. Reports are printed in either tabular or graphic form and are clear and easy to read.

Query tool. Users access student data through the Data Manager module. This module offers many attractive features, one of which is the wide variety of methods to

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present data. Users build custom reports by identifying the nature of the report through a dialogue box, choosing questions such as "What is the average?" or "How many?" This feature is very helpful in guiding users through the data aggregation process. To access groups for disaggregation, users first build each category and make it available for disaggregation. For instance, if a user planned to specify test averages for all combinations of gender by ethnicity, the user would build a category for African American males, one for African American females, one for White males, and so on until all possible combinations were built. Many different options are available for presenting data graphically, and the quality of the graphics in QSP is outstanding. QSP also offers a "report builder" that enables presentation of individual student data. User-friendly questions and notations provided along the way help the user produce the desired report. Additionally, the web version of QSP includes the capacity to create reports that link student data to teacher and parent data.

SIF. The QSP program is not currently SIF-compliant. CRESST is a grant-funded organization and CRESST personnel report efforts toward finding the proper funding to support development in this area.

Other. The web version of QSP offers an expanded set of capabilities for teachers. These include the capacity to link teacher gradebook information with the core set of student data, along with access to standards information, where available. There is also the capacity to include online samples of student work, if the school possesses the technology and resources to facilitate such storage. Schools, districts, or states using QSP Web may also participate in CRESST-sponsored research that examines issues surrounding data based decision-making.

Sagebrush Analytics powered by SwiftKnowledge

SwiftKnowledge (www.swiftknowledge.com) is a company that specializes in providing querying, analysis, and reporting solutions for organizations seeking to improve performance through data. Their education product, also called SwiftKnowledge, is designed to provide educators with easy and flexible access and presentation of student data. Recently, SwiftKnowledge partnered with Sagebrush Analytics to provide comprehensive student data and professional development software to school districts. Under this partnership, the SwiftKnowledge software was retained as the tool for reporting student data. In September 2003, we reviewed SwiftKnowledge, Version 5.1.

Data management. In the initial phases, SwiftKnowledge personnel work with school personnel to help decide which student information to make available in the school's database. There is a core set of student data that most schools employ and SwiftKnowledge personnel will also customize the data set to fit school needs. The Sagebrush/SwiftKnowledge software accesses the school's Student Information System (SIS) or other electronic data stores through a Microsoft SQL server, so there is no separate database to create. SwiftKnowledge personnel help school personnel with any data cleaning needed, then help with installation of the new hardware and software. From this point, schools are responsible for data updates and maintenance within the SIS. Data, hardware,

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and software are typically housed and managed by the school, although SwiftKnowledge offers such services when necessary.

Pre-formatted reports. Users access pre-formatted reports through the SwiftKnowledge "dashboard," a home page of sorts. On the dashboard, there are a number of different pre-formatted reports, typically about five, which the school has chosen to make available for users at a particular level, and which change from time to time. In most cases, these reports have been created by school personnel responsible for report generation, although this is a service available through SwiftKnowledge. Depending on the nature of the report, schools may choose to make available a static report, or one that allows the user "drill-through" capability to click on areas of a report and see more information about the underlying students. All reports are printable and are exportable to other software such as Excel.

Query tool. Contained in the SwiftKnowledge package are two types of query tools. One tool deals with a list of variables that are most commonly used (e.g., gender, ethnicity, assessments), while the other tool allows access to the full range of variables in the database. Although not necessarily aimed at the casual user, these tools nonetheless are accessible to all users and are not difficult to learn. Additionally, there are built-in help tools accessible to all users. These tools are flexible and powerful and allow data to be presented in either tabular or graphical format, with many user-friendly options available to customize data presentation. Data can be displayed and disaggregated longitudinally, for any number of years. Querying can also be done in "drill-down" fashion, such that users click on aggregated information to gain more specific information on students making up the aggregation. Users can also save queries for future use, and can print output or export to Excel or similar software.

SIF. SwiftKnowledge personnel report that the SwiftKnowledge application is not SIF-compliant. However, Sagebrush Analytics, the new partner with SwiftKnowledge, is a member of SIF.

Other. An appealing feature of SwiftKnowledge is the user dashboard, aimed at providing users with quick, important information at a glance. In addition to reports, the dashboard contains an "alerts" section that notes important recent changes in data (e.g., one school issues alerts when absences rise above a particular level). In addition to displaying quick information, the dashboard serves as an initial entry point to data, with access to queries and further report information. The dashboard is also customizable.

SAMS from Executive Intelligence

Executive Intelligence (www.execintelligenceinc.com) is a company that offers data warehousing and reporting tools for education. Accordingly, this company focuses on efficient and comprehensive warehousing of school data, and in presentation of this data using the Student Achievement Management System (SAMS). In September 2003, we reviewed SAMS, Version 3.4.

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Data management. Representatives from Executive Intelligence meet with school decision-makers to decide which data elements will best serve the school's needs. Once the variable set is identified, data are extracted from the school's Student Information System (SIS) into the school's SAMS data warehouse. Extraction is accomplished with the ASIX software from Executive Intelligence. After Executive Intelligence personnel install ASIX, schools continue to maintain the SIS. Automated uploads into the data warehouse are executed with the ASIX software as often as schools choose (typically nightly). An automated process is used to check data for invalid responses and the school is notified of data that need attention.

Pre-formatted reports. Pre-formatted reports in SAMS require a small amount of user specification because the reports are populated dynamically with real-time data. Specification is easy, involving only the selection of a report topic and some basic definition of report parameters, such as school or classroom. Output is clear and easy to understand, and appears in tabular form, with the option to output in an Excel spreadsheet to create charts or do further analyses. Reports can be printed from the screen or exported to PDF format. In addition to accessing aggregations at the district, school, or classroom levels, users may drill into reports to see more information about the underlying students, schools, or classrooms. Users also have access to a help screen that provides definitions of elements of reports, such as content standards from assessments.

Query tool. SAMS users may access individual student information along with disaggregated group summaries through a user-friendly query tool. This tool uses check boxes and pull-down menus to offer users guidance in formulating queries, and seems quickly learnable by any level of user. Information is displayed in tables, and users are able to drill down through any data summary to see information about the individual students making up the summary. Data disaggregation can be done with any student variable available in the warehouse, but each assessment can be disaggregated by up to two variables. At the student level, a "student profile" is available. Akin to an official student record, this profile thoroughly summarizes information on the student, such as demographic information and historical test scores, and is a helpful tool for teachers wishing to gain familiarity with individual student histories. The query tool allows for display of longitudinal information, so the user may examine data trends over time at the student or aggregate level, and allows for simultaneous display of test scores, so the user may examine longitudinal trends and associations between assessments. Data presentation is available only in tables, and can be viewed in HTML, PDF, or Excel format. Users desiring graphs and other representation may export report data to Excel and create graphs externally.

SIF. Executive Intelligence personnel report SAMS to be SIF-compliant in that SIF records can be read and produced by SAMS, but they have not gone through the SIF-certification process with SAMS.

Other. Executive Intelligence personnel report the development of a learning management tool, which links student data to assessment standards and a student's Indi-

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vidual Learning Plan. This tool will be offered as an aid to teachers wishing to use specific elements of assessment information to adapt instruction.

Scholar Suite from SCHOLARinc

SCHOLARinc (www.scholarinc.com) is a software development company that focuses on helping schools manage and analyze assessment data. SCHOLARinc offers Scholar Suite, an analysis tool for student assessment data. In January 2003, we reviewed Scholar Suite, Version 2.0; no further updates were available as this report went to press.

Data management. Once contracting to run Scholar Suite, schools gather their data from their Student Information System (SIS) and send it to SCHOLARinc in ASCII form. SCHOLARinc then merges SIS data with school assessment data provided either by the school or the state. After the initial setup, the data is housed on SCHOLARinc servers and schools update the Scholar Suite database as frequently as desired.

Pre-formatted reports. Pre-formatted reports are not available in Scholar Suite.

Query tool. The query tool in Scholar Suite is simple in focus, in that it provides users with a way to query and create graphical or tabular reports. Queries are available for the district, school, or classroom levels. The querying capability is flexible, offering any representation of assessment proficiency specified by the school. A variety of disaggregation options are available with the demographic variables in the database, although selection of variables for disaggregation is somewhat cumbersome. The graphics are clear and offer a wide range of graphical presentation, along with columnar tables of data. Scholar Suite has a degree of drill-down capacity from the graphs; at the school and classroom levels, users can click on portions of the graphs and obtain the names of students and scores that comprised that particular portion of the graph. Although users with proper permissions are able to switch between district, school, and classroom reports, the drill-down feature is only available to display student information. Users cannot, for instance, drill through from district to school to teacher to student level. Scholar Suite also offers the capacity for school personnel to enter data and link these to student data, so that a teacher, for instance, could enter data such as tests and quizzes, and have these assessments available for analysis.

SIF. SCHOLARinc reports that Scholar Suite is SIF-compliant, although SCHOLARinc is not listed among SIF-certified applications.

Socrates Data System from the Center for Resource Management

The Center for Resource Management (CRM, www.crminc.com) provides services for education such as research, program evaluation, standards implementation, and data use. One such service provides help in building school capacity to use data for improvement and accountability. This service includes the Socrates Data System, comprised of the Socrates relational database software and the Socrates Data Web, a customized web por-

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tal for accessing reports and other information (www.crminc.com/Socrates1.htm). We reviewed the Socrates Data Web, Version 2.2, in September 2003.

Data management. In the initial phase of the relationship, CRM personnel work with school and district personnel to identify the data that are available to be imported into the Socrates database. School personnel then organize and send the data in electronic form (Socrates accepts common data formats) to CRM to be loaded into the Socrates database. While loading the school data into the Socrates database, CRM personnel perform a cleaning process, producing reports of specific data elements and records that need attention. Once the database is ready for use, CRM houses and manages the data for the first year, receiving data updates from the school at time intervals chosen by the school. When school personnel feel ready, they then can opt to buy a Socrates site license and take over data management themselves. Otherwise, they can contract with CRM to continue housing the data. Schools continue to maintain their Student Information System and periodically update the Socrates database. These updates can be done as often as the school chooses, regardless of where the database is housed and managed.

Pre-formatted reports. Users of the Socrates Data Web component of the system access a voluminous amount of prepared reports available at the district, school, and program levels. If a school requests, classroom-level reports and individual student profiles may also be made available. These reports require no specification by the user; the user simply selects the report from a list, then either views or prints the report, so the software provides a great amount of prepared information with a few clicks. A large number of core reports (e.g., disaggregated assessment results, discipline, and attendance) are included, and schools may also request any number of additional reports showing relationships among items in the district's database. Reports are arranged by level, such as district or school level, then within each level, specific reports are intuitively arranged into groups such as enrollment and absence data, achievement tests, and class grades. Reports can be specified in any presentation format a school chooses (e.g., tables, charts, any graphical form), and are clear, concise, and easy to read in all of the formats presented. Tables are consistently formatted from report to report, so the user quickly becomes familiar with the appearance of the tables.

Query tool. CRM personnel report research and experience that indicate that having to learn a query process to access data can be a significant obstacle to data use in any data warehouse system. Consequently, the Socrates Data Web was created to provide access to reports (see "Pre-formatted reports") that CRM personnel believe address the majority of data questions. CRM provides training for designated school and district personnel and other users who wish to perform ad-hoc queries in the database.

SIF. CRM personnel report that Socrates does not yet meet specifications for SIF compliance.

Other. The Socrates Data Web also comes with a Resources section that contains articles, worksheets and guidelines for using data, and websites on topics of interest to school personnel. These works are drawn from educational literature and CRM's own research. CRM personnel report communication tools in the works, such as electronic

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discussion boards to enable Socrates users to contact each other regarding Socrates and other data issues.

STARS from SchoolCity

SchoolCity (www.schoolcity.com) is an education software company providing data software and e-learning services to school districts. For student data analysis, SchoolCity offers the Standardized Test Analysis and Research System (STARS, www.schoolcity.com/stars.htm), a tool formerly owned by the American Productivity and Quality Center. The focus of the STARS software is on providing disaggregated student assessment data. In September 2003, we reviewed STARS, Version 2.6.

Data management. To begin the data process, district personnel collect a defined set of student data comprised of 23 fields of demographic and academic information such as gender, ethnicity, and course grades. These data are collected by the school from the school's Student Information System (SIS) and submitted to SchoolCity in ASCII format. SchoolCity personnel then obtain student assessment data from the appropriate source (typically a state, publisher, or school) and merge assessment data with the school-submitted SIS data to create the school's STARS database. Since the set of 23 SIS variables is pre-set, SchoolCity personnel typically do not help schools with data collection and identification, although this service is available if needed. Schools also can include student data in addition to these 23 fields, but these variables must be submitted separately and imported with the assessment data. In the typical arrangement with SchoolCity, schools house and manage their databases, and updates are done every term. Services are available, however, for SchoolCity to host and manage the data; more frequent update options are also available.

Pre-formatted reports. When users log in to STARS, a set of pre-formatted reports is available, offering information according to the user level. For instance, a teacher may choose from reports pertaining to her/his students, while a principal may access reports pertaining to the entire school. Examples of report content available in the STARS implementation include minimum standards proficiency and average achievement test scores, disaggregated by a number of demographic variables. These reports are easy to access and understand, and are available in tabular and graphic forms. Reports are printable and are exportable to Excel.

Query tool. The STARS software offers various methods to query the data. One form of querying allows users to run the same reports available in pre-formatted form, but selecting certain characteristics of the available sample of students. Users can drill through these reports to obtain information on the participants making up certain areas of the reports. There is also a more powerful query tool that allows the user freedom to manipulate both the sample characteristics and presentation of assessment data. This tool provides a variety of methods to present and disaggregate assessment data, with a limited range of longitudinal data and multiple assessments. To bolster capacity to view concomitant data, SchoolCity will soon release a new query tool with STARS that allows up to six assessments in one report. The six assessments available can be separate tests, tests

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given over a number of years, or a combination of both. All of the STARS query methods are intuitive to operate, using familiar check boxes and pulldown menus.

SIF. SchoolCity personnel report that STARS is not currently SIF-compliant, citing a lack of demand from clients for SIF-compliant software. SchoolCity personnel report familiarity with SIF requirements and may move toward SIF-compliance at a future date.

Virtual EDucation from EDmin

EDmin (www.edmin.com) is a company with the stated goal of improving schools by providing technology that electronically connects all stakeholders surrounding a school, including educators, students, parents, and other community members. EDmin offers the Virtual EDucation software package (www.edmin.com/products/ved/index.cfm) as part of this mission. EDmin describes Virtual EDucation as a "learning management system" that enables educational improvement by offering connections between many different aspects of school life. Examples of modules contained in Virtual EDucation include instructional management (e.g., lesson planning, grades), school newsletters, access to learning standards, online student portfolios, and student data analysis/reports. The student data modules are targeted specifically at presentation and disaggregation of student assessment data. In September 2003, we reviewed the student data modules of Virtual Education, Version 5.5.

Data management. Before data collection starts, EDmin personnel meet with school personnel to help identify which variables will be imported into the school's database. These variables typically consist of any assessment variables a school has, along with a set of up to 15 demographic variables for disaggregation purposes (e.g., gender, ethnicity). Once variables and their sources are identified, schools collect, clean, and send the data to EDmin in any electronic format (tab-delimited is preferred). EDmin personnel subsequently perform a cleaning process on the data and notify schools of needed changes. Once clean, the data are loaded into the school's Virtual EDucation database. The school or district continues to maintain their Student Information System, updating the database as often as needed. EDmin typically houses the school's Virtual EDucation database, though the school can choose to house it on their own server instead.

Pre-formatted reports. The Virtual EDucation package does not contain a set of pre-formatted reports.

Query tool. The query tools within Virtual EDucation provide a number of ways to build reports on student assessment data. The tool is easy to learn, using pull-down menus to define the sample and assessments for the desired report. The tool is a nice combination of flexibility and guidance, in that users are allowed to select and group students whom they are permitted to view, but can click on links to obtain certain types of reports about these students. For instance, there is an "at-risk report" available where relevant information about students scoring below a specified test score is presented and a "progress chart" that displays test score changes for schools, classrooms, or students

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over a given period of time. There is also the capacity to display trends for multiple assessments simultaneously. A great deal of flexibility is provided by the "drill-down" capacity in these reports, enabling the user to click on any aggregated set of data and obtain information on the participants who make up the specific group. Most reports are available in tabular form, with the option to re-sort tables in many different ways. Graphs and charts are typically not available immediately; users who wish to create graphs must export the data to Excel or another graph-creating tool. There are also ample links to and integration with other modules included in Virtual EDucation; for instance, it is easy to link to assessment standards from many result tables.

SIF. EDmin representatives report that they have not yet begun the SIF-compliance or certification process, but that Virtual EDucation is SIF-compliant. Company representatives report a desire to wait until more definitions are set by SIF before starting the compliance or certification process.

Locally Developed Software

School districts sometimes choose to build their own student data analysis system. We spoke with three large districts in Broward County, Florida, Cleveland, Ohio, and Houston, Texas, that have done so and are currently implementing these systems in their schools. We were not able to review these programs, but spoke with representatives and viewed presentations of the software.

These locally built systems appear to offer similar capacities as the publicly-available programs reviewed above. All were built by Information Technology (IT) staff employed by the district, and were integrated directly into the existing Student Information System. This was supported in different ways. Broward County, for instance, obtained a grant to partner with IBM for help in building the data warehouse. In Cleveland, the project started on a small scale, with IT employees building a limited access tool for the database. The Cleveland project continues to grow in scale. All software was developed with local needs in mind, and all continue to evolve within this context.

Houston offers a comprehensive package that enables queries and drill-down capacities. The access to a wide range of student data is impressive and the system looks as if it is easy to use. Broward County also offers a wide range of access, and has placed emphasis on report availability. In addition, Broward County continues to push forward user queries, recently rolling out versions of query tools aimed at every level of expertise. Cleveland's program is in an earlier developmental stage than the other two, and offers presentation of snapshots of student data with analysis available from a data download to a program such as Excel. The IT staff in Cleveland report a heavy emphasis on training users on the use of the software and in Excel.

All three of these local efforts are only available locally, so school personnel must be on school grounds to access them. Broward County and Houston report efforts to enable Internet access to their programs, with the necessary privacy concerns kept firmly in mind. Cleveland is not moving as quickly toward Internet access. Since users download

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student data for analysis, such analysis takes place at the PC level, so the data have a degree of portability.

All three locations further report a very positive response to these initiatives. All report rapidly increasing numbers of new users. In addition, all three locations report positive response to training that enables the user to run ad-hoc analyses.

DISCUSSION

We have examined issues surrounding a proposition that is prevalent in both the business management and school effects literature—that creating a more nearly data- and information-rich environment can help improve practice and performance. School research and our own observations indicate that being "data-driven" is a phenomenon more often observed in the breach than in the basic structure of the typical school. We have also observed that the absence of data-informed decision-making is not inherently due to educators' aversion to being informed. Rather, the wealth of data potentially available in schools is typically not stored in ways that are practically accessible to teachers and principals.

This wealth of data need not remain inaccessible. There are many software tools, both locally built and commercially available, to facilitate access to interpretation of data. Advancements in computer technology have created powerful, affordable hardware to support these tools, and this technology is getting more powerful and less expensive. Software development in this area is producing even more efficient and usable tools for educators.

Many issues remain surrounding the use of student data for decision-making. These issues provide ample opportunity for further research within this area, and will be addressed in the remainder of this section. In discussing each issue, we outline a series of 11 important research questions, each of which could be addressed through a relatively straightforward experimental study.

Educator Use of Student Data Software

Throughout this report we have discussed the need for developers to listen to and observe the needs of educators. Based on our experience with testing software, interviewing developers, and working with educators, we have speculated as to what an excellent software package might provide. A necessary next step is to provide rigorous studies of educators' use of data analysis and presentation software.

There are several references available that discuss others' observations regarding the nature of the school data process and educator involvement (e.g., Lachat, 2002; Feldman & Tung, 2001). However, there do not yet exist controlled studies that examine educator use of student data software, and the effect of such use on student outcomes.

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Research Question 1: *What practical use do teachers and principals make of rich classroom- and school-level data information tools, when they are available?*

Research Question 2: *What types and levels of professional development are most effective in assisting teachers and principals in becoming facile users of such data and data tools?*

Research Question 3: *As educators become skilled users of rich, multi-dimensional student data at the student, classroom, and school levels, how do these skills affect their teaching?*

Research Question 4: *To what extent do these changes in teacher and principal knowledge and behavior affect student achievement and other desired outcomes? (e.g., Can the promise of "data- and information-richness" for improving students' academic achievement gains be documented in controlled experiments?)*

Building and Maintaining a Data Climate

Data access is a necessary condition for promoting data-informed decisions, but it is not a sufficient condition. To make the best use of such access, schools must create a climate that encourages data use, lends proper technology for efficient access and interpretation of data, and provides professional development opportunities to ensure that teachers and other educators are able to make the most of their data.

Without a data-driven climate, even the best access to data is doomed to use by only a few unusually interested parties. School leadership must support and expect data-driven decision-making. This almost certainly means providing time for such endeavors, and promoting opportunities for collaboration and support from other educators. Data use should be promoted near the top of an educator's priority list, to be envisaged as part of a continuous cycle of data analysis, lesson planning, lesson presentation, and data gathering. Further, a data-driven climate must be structured such that data use is an expected part of an educator's normal day, as are lesson planning or grading.

Research Question 5: *What administration behaviors, at the district and school levels, will be necessary to create and to sustain a data-focused, data-driven decision-making climate at the classroom and school levels?*

Research Question 6: *What types and levels of professional development are most effective in supporting and sustaining a data-focused, data-driven decision-making climate at the classroom and school levels?*

Teachers as Researchers

Providing access to student data to inform educational practice would directly support those furthering the ideal of teachers as researchers. Throughout this report we have implied that it is not necessary that teachers first become experts in statistical data analysis. We do not envision most classroom teachers using newfound access to student data to employ a full range of inferential statistics, sampling methods, and all the other hallmarks

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of traditional quantitative research methodology intended to allow inference from a sample to a larger population. Quite understandably, most teachers are less interested in statistical inferences to broad populations, and most interested in one specific population of students—their own.

Research Question 7: *Given broad access to student data histories and additional knowledge about their students, what forms will teacher research assume? Will teacher examination of student data be descriptive in nature or take on more complicated forms?*

GIGO

In this report, we advocate very broad access for teachers and other education professionals, but access of this kind brings its own set of problems that should be addressed. Any profession attempting to expand its knowledge base confronts the phenomenon of GIGO—garbage in means garbage out. We anticipate that professional development will be required to minimize misuse of some unjustified but readily available comparisons, and that software should offer restrictions to help enable sensible comparisons. An example of misuse might be the literal comparison of scores on different measures.

Research Question 8: *What forms of professional development and software designs will most nearly ensure the educationally defensible use of the wealth of readily available comparisons offered by broad access to data?*

Beyond Accountability

Earl and Katz (2002) state that data are best used for improvement purposes, rather than for accountability purposes. We believe data use such as that promoted in this report will provide a positive complement to current "macro" data collection. Many educators are suspicious of data use, often feeling "used" by it (Earl & Katz, 2000). Data use such as that promoted here provides a measure of control over the use of this data—a way to use data instead of being used by data. Moving beyond accountability promotes intrinsically motivated exploration and holds great potential for informing teacher classroom practice.

Research Question 9: *How will use of student data beyond accountability affect teacher self-efficacy and motivation toward further data use?*

Teacher Preparation

Most teacher preparation programs currently do not provide preparation in the area of data based decision-making. Teacher preparation researchers for years have stressed teacher inquiry into practice and effects (Goodlad, 1990; Holmes Group, 1990), and the marriage between data use and teacher preparation is a natural one. The current generation of college students is the first to have grown up with computers, so experience with computers and instant access to information is generally not the obstacle for many preservice teachers that it might be for some senior educators.

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Teacher preparation programs are beginning to implement courses aimed at data use through action research and assessment methods. These programs would additionally benefit from recognizing the utility of software such as that described here and quickly expanding preparation of teachers to engage in data based decision-making.

Research Question 10: *When teacher candidates are prepared to use student data, will they continue data practices once they enter the teaching profession? Will these teacher candidates become more effective teachers than candidates not prepared for data use?*

Online Portfolios

Currently, the majority of both locally and commercially developed data warehouses focus on quantified data. Only a few allow for the storage of more "authentic" measures of students' academic performance. The historic argument against storing full student portfolios was one of storage costs. However, the cost of data storage has plummeted and continues doing so, making the cost argument less compelling.

Research Question 11: *Will the presence of more nearly "authentic" student work, such as handwriting, artwork, essays, or PowerPoint presentations for classes prove sufficiently valuable to teachers and administrators, where such storage is available, to create a demand for such functionality? Will the additional functionality, where present, serve to further data use and student achievement?*

SUMMARY

We believe the development of tools for classroom- and school-level use of student data represents an important opportunity for informing educational practice at both the school and classroom levels. The opportunity for today's educators to tap into the great wealth of presently accessible student data no longer needs to be an abstraction.

Although the use of this technology is not yet widespread, efficient, practical implementation of data management technology is available today. The use of data to manage information has been widespread in other fields for a number of years. Both local districts and for-profit corporations have spent much of the last decade developing and refining products that facilitate the storage, analysis, and presentation of educational data in a range of levels.

There are many questions yet to be answered as to how the evolution of these technologies will proceed, how they will and should be managed, and what standards will emerge. In this report we have proposed a series of areas both for additional practical use of these technologies and for research on how to maximize that productive usage.

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APPENDIX A

There are also a small number of software companies that we were unable to review for this report, but who provide analysis of student data. Achieve, from Project Achieve, offers analysis of student data related to state learning standards, and EADMS, from Adrylan Communications, offers analysis of student data by way of pre-formatted reports. Unfortunately, we were unable to get a hands-on demonstration of these two products and the opportunity to actually operate the software was a criterion for inclusion in this study. Pearson Education Technologies (formerly NCS Learn), the company that offers SASIxp, lists on their website software that analyzes student data, but repeated attempts to make contact with various company personnel for a demonstration were unsuccessful. In addition, we reviewed a demonstration of the Achievement Management System from TurnLeaf, but TurnLeaf requested not to be included in these reviews. It is our hope that subsequent updates of our work will include these vendors.

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APPENDIX B

To give the reader a better sense of the look and feel of these programs, we asked each vendor included in our reviews to send an example of their software. This appendix contains "screen shots" from vendors who provided examples of their software.

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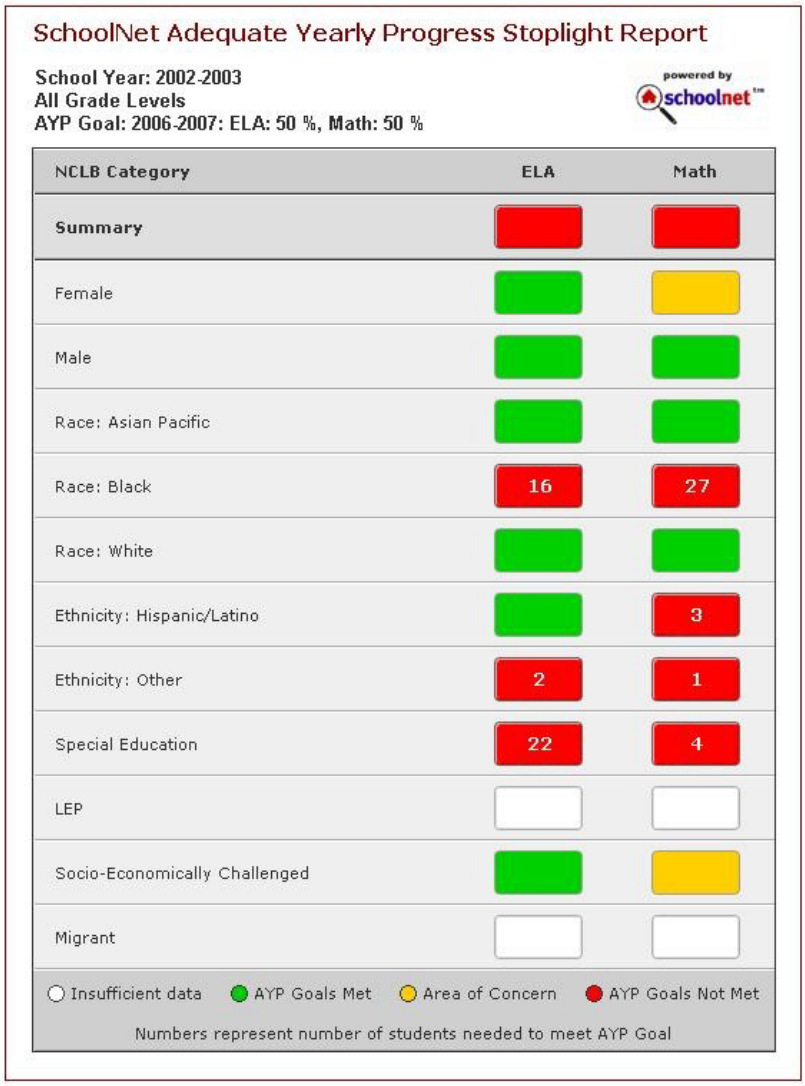
Account from SchoolNet

Below is an example of the AYP Stoplight Report available in SchoolNet for NCLB reporting. Groups are coded in green if meeting a particular AYP goal, yellow if nearly meeting the goal, and red if substantially behind the goal.



SchoolNet Adequate Yearly Progress Stoplight Report

School Year: 2002-2003
All Grade Levels
AYP Goal: 2006-2007: ELA: 50 %, Math: 50 %

powered by schoolnet™

NCLB Category	ELA	Math
Summary		
Female		
Male		
Race: Asian Pacific		
Race: Black	16	27
Race: White		
Ethnicity: Hispanic/Latino		3
Ethnicity: Other	2	1
Special Education	22	4
LEP		
Socio-Economically Challenged		
Migrant		

○ Insufficient data ● AYP Goals Met ● Area of Concern ● AYP Goals Not Met

Numbers represent number of students needed to meet AYP Goal

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DataPoint from NSSE

Below is the Main Menu from DataPoint. Users may choose a variety of options, including custom analyses, searching for individual students, and resources from the NSSE school improvement plan.

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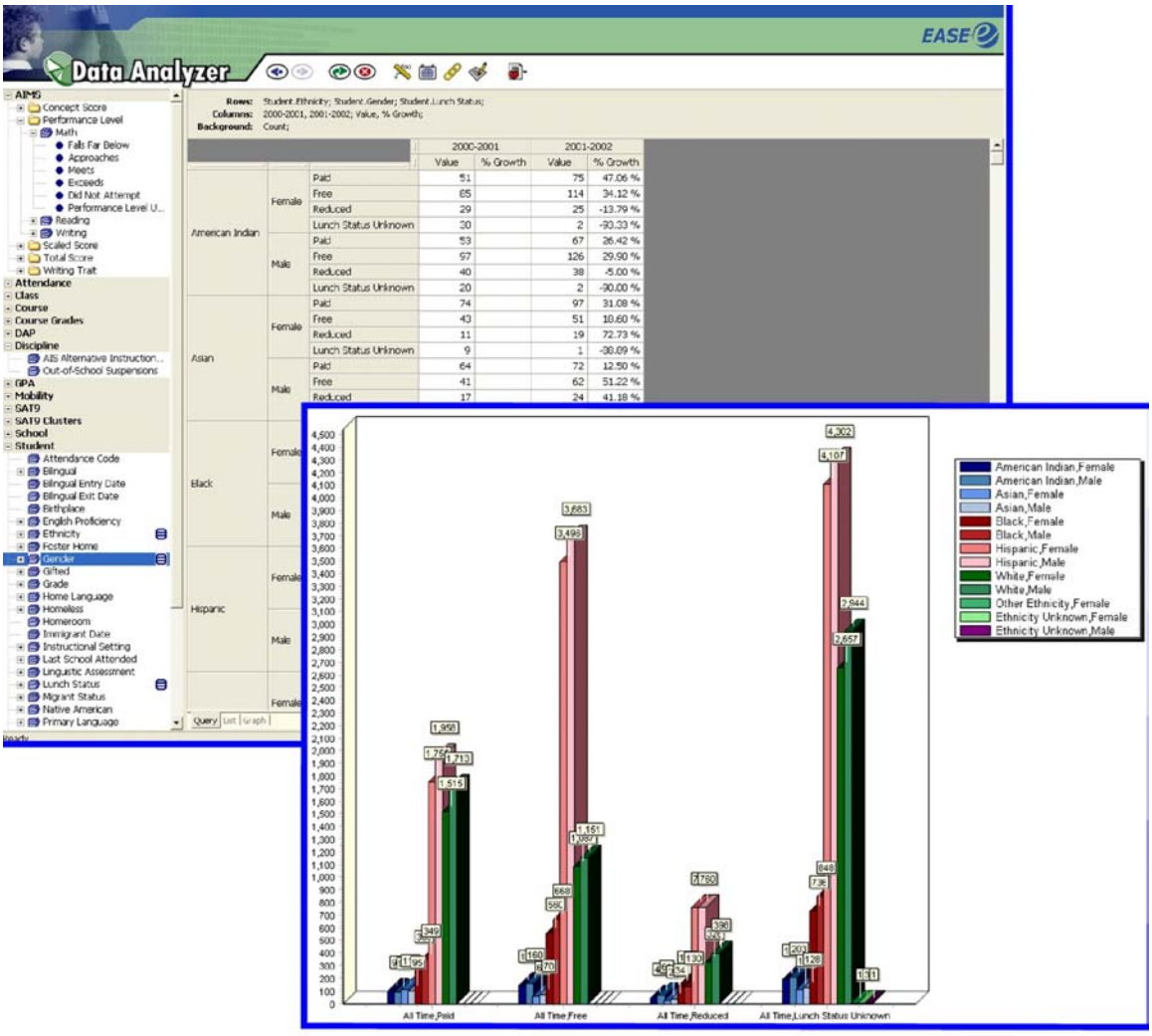
Ease-e by Tetra Data

Below is output from the Ease-e Data Analyzer, showing an example where counts of students are disaggregated by free lunch program, ethnicity, and gender. Output is initially given in tabular form, with other forms also available (graph shown on inset).



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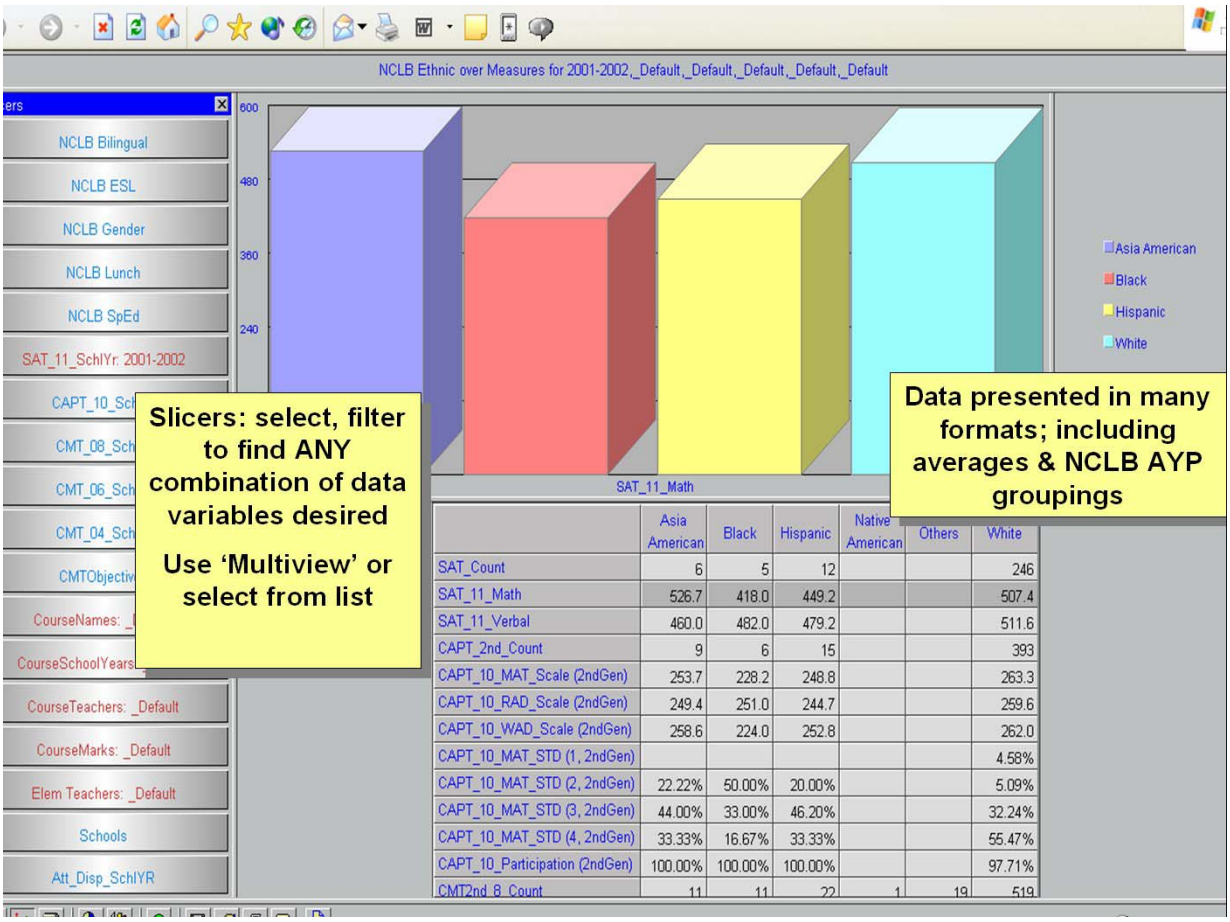
EDsmart

This screen shot illustrates the EDdiscover module from EDsmart. Analysis variables are chosen from “slicers” on the left, and aggregations are presented in tables and graphs on the right.



	Asia American	Black	Hispanic	Native American	Others	White
SAT_Count	6	5	12			246
SAT_11_Math	526.7	418.0	449.2			507.4
SAT_11_Verbal	460.0	482.0	479.2			511.6
CAPT_2nd_Count	9	6	15			393
CAPT_10_MAT_Scale (2ndGen)	253.7	228.2	248.8			263.3
CAPT_10_RAD_Scale (2ndGen)	249.4	251.0	244.7			259.6
CAPT_10_WAD_Scale (2ndGen)	258.6	224.0	252.8			262.0
CAPT_10_MAT_STD (1, 2ndGen)						4.58%
CAPT_10_MAT_STD (2, 2ndGen)	22.22%	50.00%	20.00%			5.09%
CAPT_10_MAT_STD (3, 2ndGen)	44.00%	33.00%	46.20%			32.24%
CAPT_10_MAT_STD (4, 2ndGen)	33.33%	16.67%	33.33%			55.47%
CAPT_10_Participation (2ndGen)	100.00%	100.00%	100.00%			97.71%
CMT2nd_8_Count	11	11	22	1	19	519

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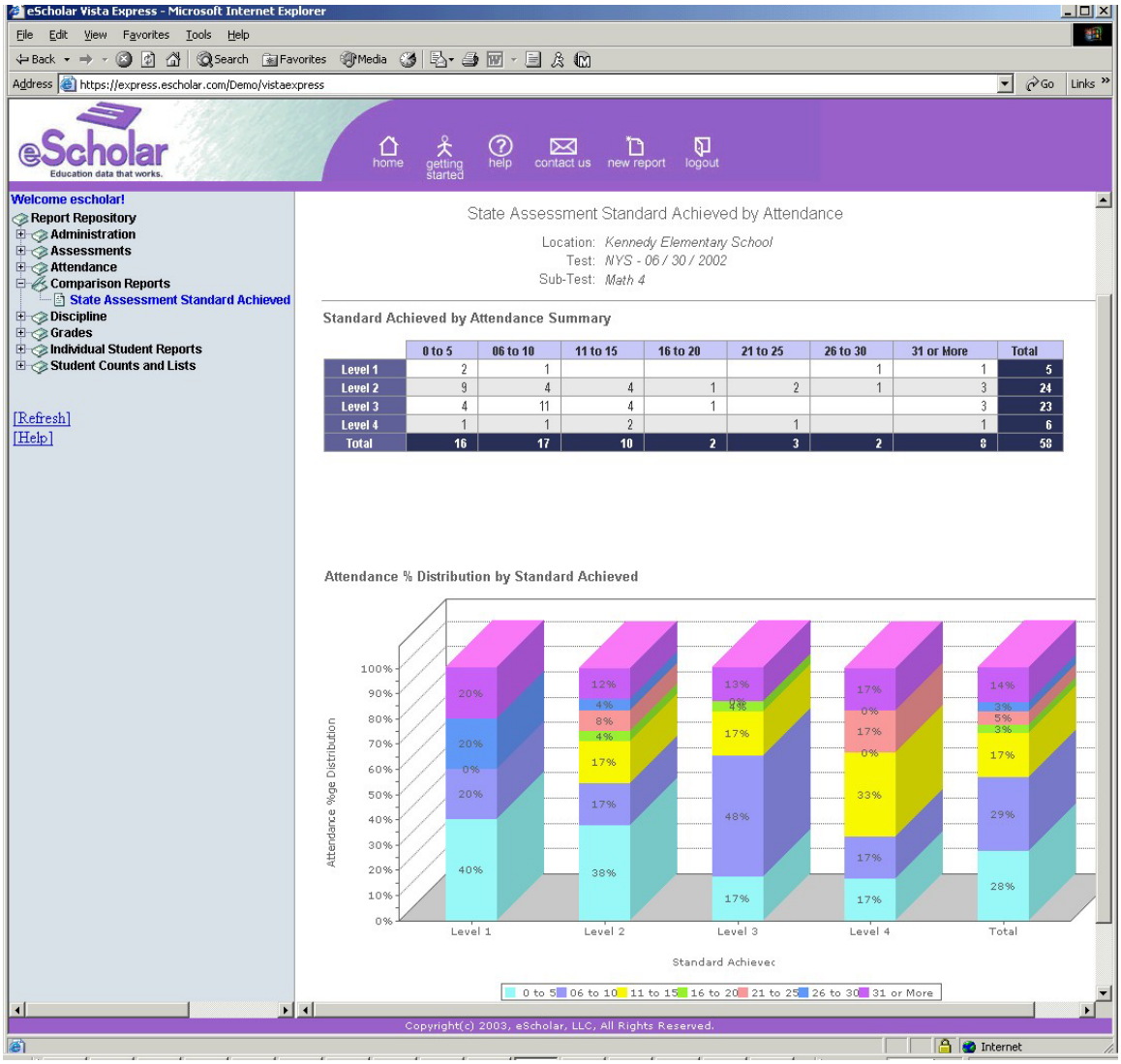
eScholar

Below is an example of output from the Vista Express reporting tool. This particular report presents assessment achievement disaggregated by attendance.



	0 to 5	06 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 or More	Total
Level 1	2	1				1	1	5
Level 2	9	4	4	1	2	1	3	24
Level 3	4	11	4	1			3	23
Level 4	1	1	2		1		1	6
Total	16	17	10	2	3	2	8	58

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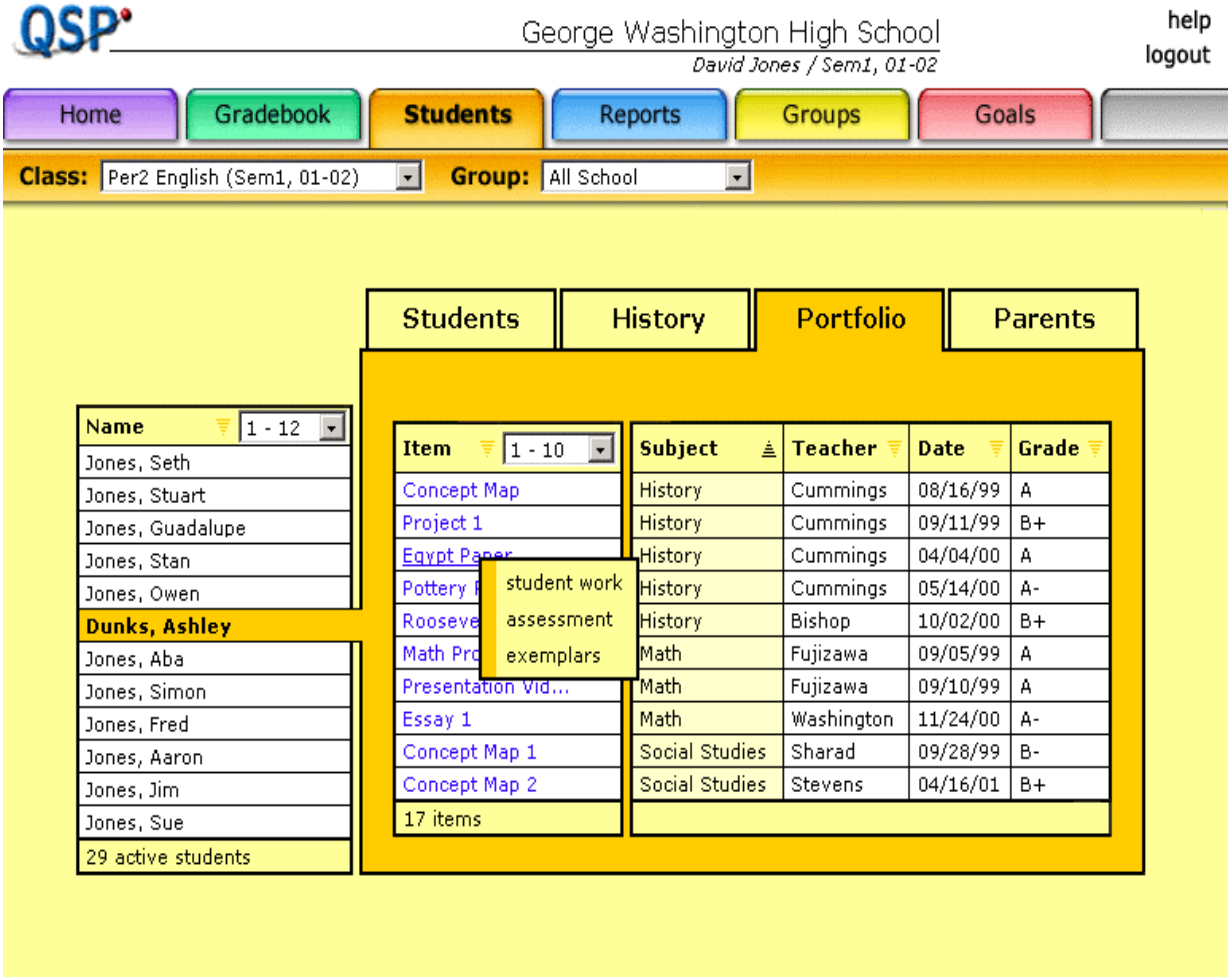
QSP from CRESST

This example illustrates the capacity of QSP to aid in producing a report of varied academic information on individual students.



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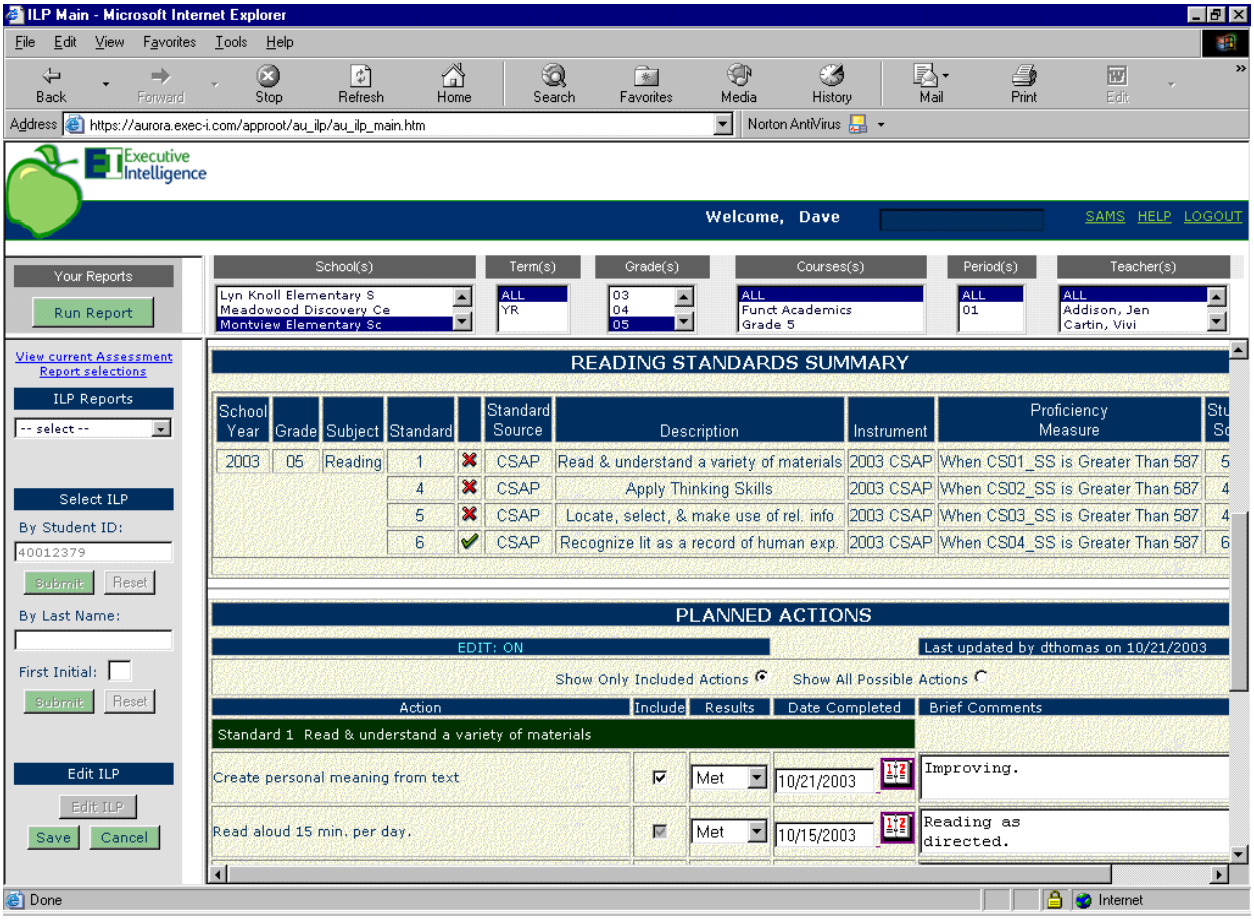
SAMS from Executive Intelligence

Below is an example from SAMS, summarizing test performance for an individual student. A summary is given for standards within the assessment, along with action information regarding a specific standard.



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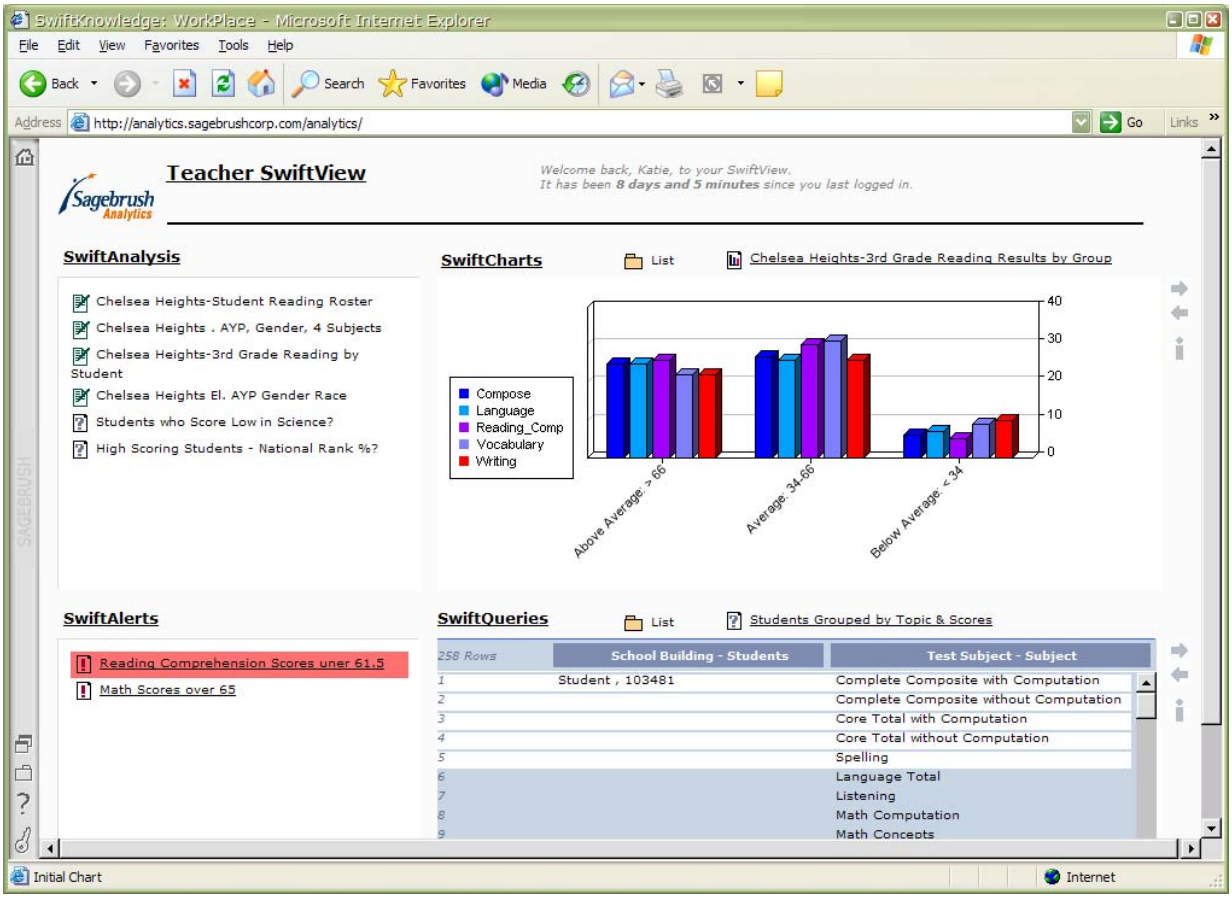
Sagebrush Analytics, powered by SwiftKnowledge

This is the initial user screen from SwiftKnowledge. Users may access reports on the top, queries on the bottom right, and are alerted to recent important information through SwiftAlerts on the bottom left.



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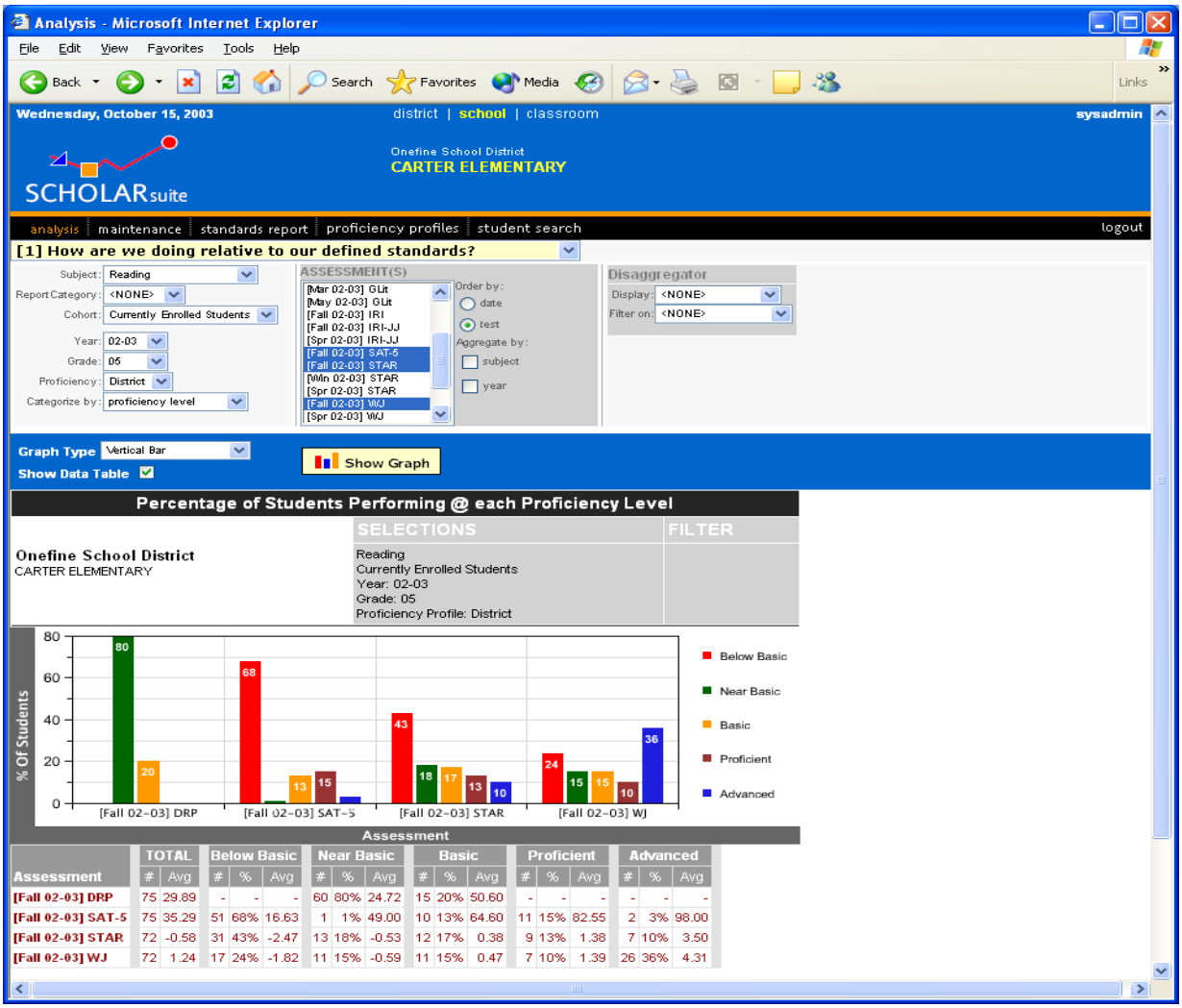
Scholar Suite from SCHOLARinc

This is an example of simultaneous assessment presentation in Scholar Suite. This particular report presents proficiency on four different tests, side by side.



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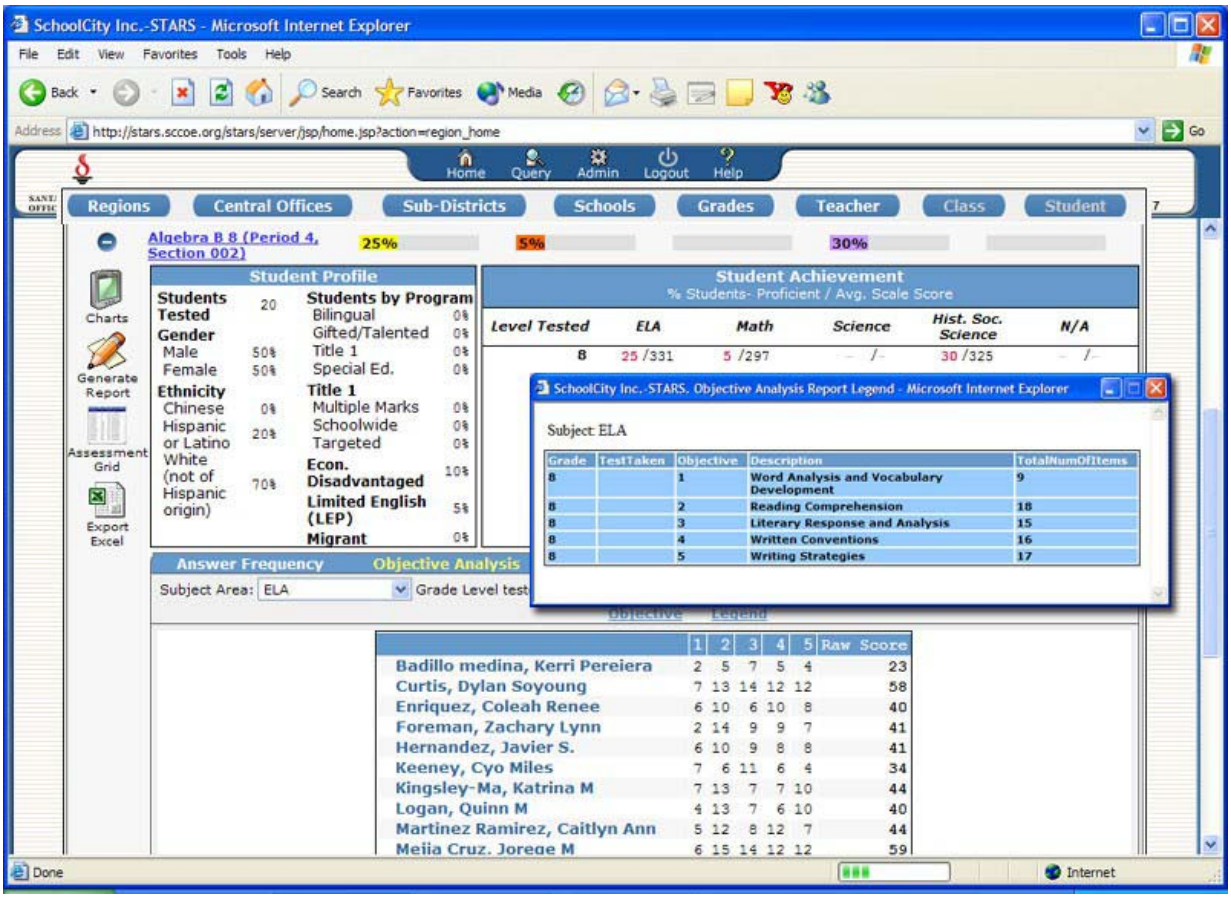
STARS from SchoolCity

This shows an example of drill-down from the classroom to the student level. The inset presents descriptions for specific assessment objectives.



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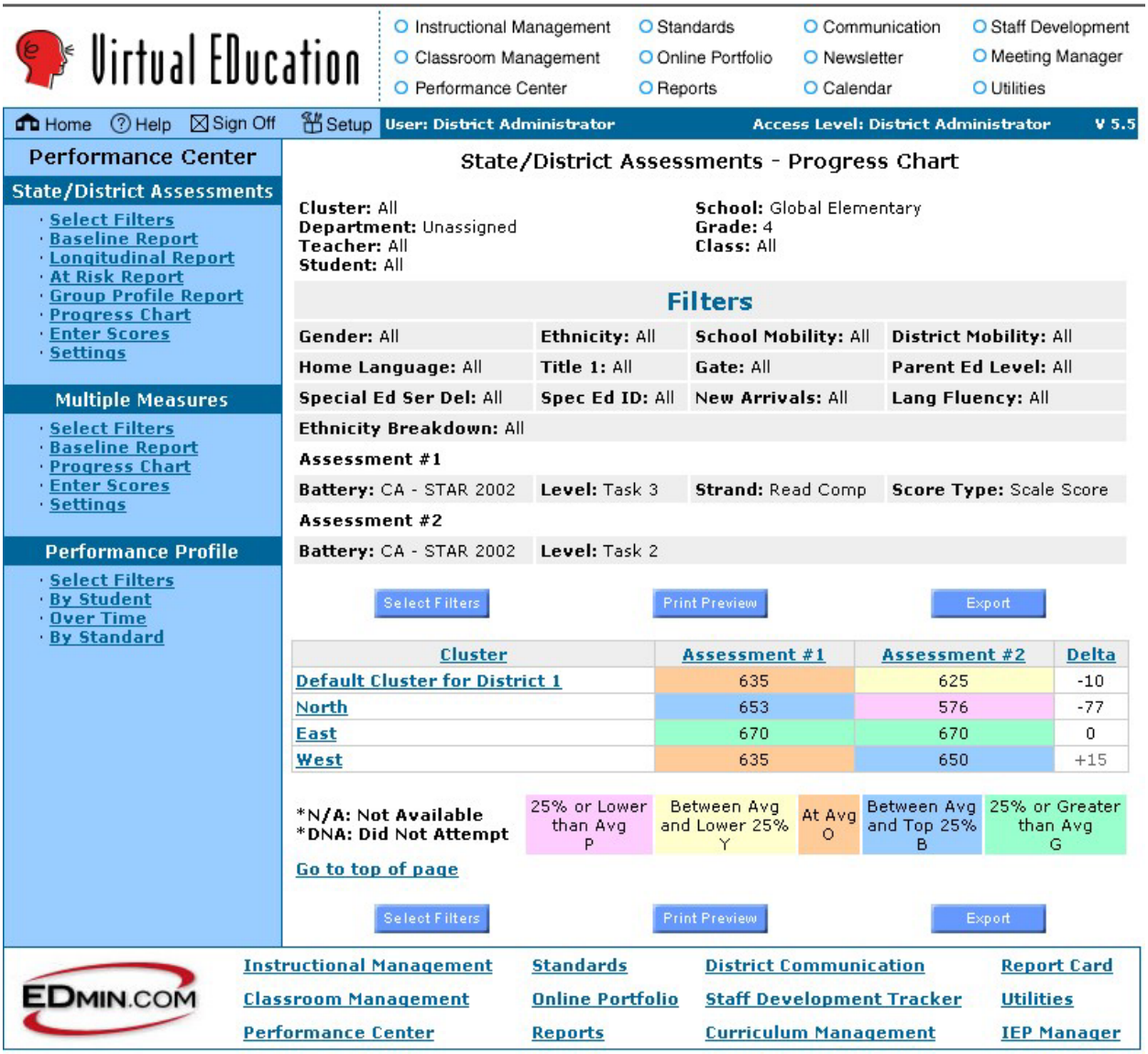
Virtual EDucation from EDmin

The report shown here enables users with proper permissions to see all of the student achievement and performance gains for an entire year, helping to track AYP. Users may click on links under "Cluster" to drill down as far as the individual student level.



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