

**Leveraging the Systems and
Applications Being Developed by the
Race to the Top Assessment Consortia
to Advance Teaching, Learning and
Assessment in Content Areas Other Than
English Language Arts and Mathematics**

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Forty-five states and the District of Columbia are participating in the two assessment consortia known as the Smarter Balanced Assessment Consortium (Smarter Balanced) and the Partnership for Assessment of Readiness for College and Careers (PARCC). In 2010, the consortia received \$360 million in Race to the Top Assessment Program (RTTAP) funds from the U.S. Federal Government, to design, develop, and test new assessment systems in order to “measure student achievement against standards designed to ensure that all students gain the knowledge and skills needed to succeed in college and the workplace” (Department of Education, 2010, p. 18171).

Both Smarter Balanced and PARCC are developing a series of digitally based system components that will be made available to states at the consortium level over the next few years. Based on the separate consortium timelines for development and implementation of these new systems, the K-12 Center at ETS has been developing two papers, one for each consortium, that give overviews of these new systems. The current paper, which is focused on Smarter Balanced, and the second paper, which will be focused on PARCC, will explain the goals and objectives of each consortium and how the emerging assessment systems will support not only the Common Core State Standards (CCSS)¹ in English language arts and mathematics but how stakeholders in other content areas can leverage these systems to prepare students for college and career more effectively. Both of the consortia’s systems are centered on the concepts of multi-tenancy and interoperability.

¹ The Common Core State Standards in English language arts and mathematics were developed under an initiative led by the National Governor’s Association and the Council of Chief State School Officers and were voluntarily adopted by the states participating in PARCC and Smarter Balanced.

Part I. The Promise of Multi-Tenancy and Interoperability in K-12 Education

What Is Multi-Tenancy?

The ways in which we access and share digital information are changing. The days of individual vendor software products that need to be installed, maintained, and updated on every computer are ending. Just as floppy disks gave way to CDs, individually owned software packages are giving way to online downloads and real time content streaming, and *multi-tenancy* has evolved from this shift. Multi-tenancy refers to the ability of multiple users (tenants) to access one set (or instance) of software and digital resources, while retaining local configuration specifications and confidential data protection. In other words, every tenant can access all the same software capabilities, but their individual data are not shared with other tenants.

Many of us have already experienced a form of multi-tenancy through services such as Gmail and Dropbox. With a high-speed Internet connection, we can freely access these programs and individually configure our Gmail and Dropbox interfaces to suit our preferences. However, our personal data and stored files are not shared with other Gmail or Dropbox users unless we specifically choose to share them. As long as we have a dependable Internet connection, we can access these resources regardless of platform (e.g., PC or Mac) and with no special on-site system requirements. In the context of RTTAP, states will be able to access all of the assessment system components being developed for their consortia, in a platform-independent manner and regardless of content area. At the same time, privacy and data security will be maintained, just as it is now with proprietary in-school systems.

Educators and developers in science, history, art, and other content areas will be able to access and use the system components in a similar manner as educators in the ELA and mathematics content areas. In addition, many of the software system components being developed will ultimately be made open source, as long as the system components use the respective interoperability standards adopted by each consortia. Open source means that the tenants will not only have access to configuration options but to the source code itself, by which they will be able to adapt the system components to their specific needs. In this way, a consistent environment for the development of new assessment modalities and items across content areas is maintained, but states will be able to tailor the assessment experience to their own constituencies. In addition, vetted professional development and instructional resources can be shared and, with a common tagging scheme, readily searched and located to meet evolving needs.

The software and digital resources accessed by the tenants are maintained in a central location on a server, which is often referred to as part of the cloud. The cloud approach to obtaining and sharing data and resources can significantly reduce costs for school IT staff needs in terms of internal computer and software maintenance. Schools or school districts will not need to have powerful computers with plenty of RAM just to access resources in the cloud. Updating software is a much simpler affair, as new

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versions can be rolled out to all tenants at once, eliminating the need for tenants to purchase, install, and maintain the latest software versions on site to access the consortia's systems.

What will be required for effective learning and data sharing are computers with a modern browser and a dependable connection to the Internet. In this way, cloud computing and multi-tenancy greatly simplify hardware and software needs within individual schools. However, the infrastructure requirements to provide access to high-speed Internet in schools are significant and should not be underestimated. For this reason the Smarter Balanced and PARCC consortia have collaborated on a technology readiness tool (see <https://www.techreadiness.net>) to help schools determine their infrastructure needs are to access and make use of the assessments and system components being developed. In addition, the Smarter Balanced consortium is developing a temporary paper-and-pencil version of its assessments for those for who have special computer access challenges in 2014–2015.

What Is Interoperability?

Another requirement for effective use of the new assessment systems by schools, districts, states, and even the consortia are interoperability standards that meet the diverse data-sharing requirements of this new paradigm. Interoperability refers to the ability of different systems, applications, and components to communicate with each other to share data and work together in a seamless manner. Interoperability is widespread and effective across a variety of industries, but until recently, numerous efforts toward interoperability in education have stalled and few efforts have been widely adopted. Developers and vendors have not had sufficient incentives to create interoperable systems for education and in many cases have significant disincentives to do so. To date, school districts and universities have typically chosen a single major vendor through a request-for-proposal (RFP) and bidding process, leading to a solution that does not necessarily support interoperability and often creates disincentives for that vendor to support interoperability.

RTTAP and CCSS have contributed to the impetus to share a variety of content more effectively among educational software systems. Collaborative efforts between education and industry, such as the Learning Resource Metadata Initiative (LMRI), InBloom, and the Learning Registry, promote shared content knowledge and an application-centric view that supports standardized data platforms as additional options in the marketplace. RTTAP grants include requirements for interoperability of the systems built by the consortia (Common Education Data Standards, 2012). Therefore, the consortia are working to develop systems in which the components “plug and play” seamlessly with one another within the consortium architecture (see Figure 1). In addition, the design allows for states to choose to replace specific components with ones developed by the state(s) or vendors that have adopted the interoperability standards.. This approach will permit customization of the systems by the states, including use of the systems for additional content areas, while preserving critical elements necessary for maintaining the consistency in the meaning of the assessments. The result of these efforts is the

potential for a consistent assessment experience for students, teachers, and administrators in K-12 education.

Advantages of Multi-Tenancy, Interoperable Consortia System Components for All Content Areas

Improved assessment experience consistency. In this new assessment environment, students, teachers, vendors, and administrators all will have to adapt to new ways of teaching, learning, and interacting with technology. If educators in content areas beyond ELA and mathematics had to find or set up their own systems in this new assessment environment, the resulting lack of consistency and interoperability between the systems they developed could impede the evolution of this new initiative significantly, not to mention increase frustration and general inefficiencies.

One of the primary advantages of the multi-tenant nature of the consortia resources is the opportunity to develop assessment items, student assessment experiences, and test administration/delivery processes that are consistent across multiple content areas. Each group involved in assessment benefits as follows:

- For students, assessment experience consistency means not having to learn a completely new interface or interaction dynamic to access and complete assessments in content areas other than ELA and mathematics. This advantage may be particularly important for the alternate assessments being developed for students with disabilities.
- For teachers, assessment experience consistency means accessing the same portals, dashboards, digital libraries, and item banks and use them to find professional development and instructional resources and to find, plan, and author assessments in multiple content areas. This will likely result in less confusion about different systems, logins, and support.
- For test administrators and vendors, assessment experience consistency means needing fewer assessment delivery strategies because of shared use of delivery and reporting platforms, user interfaces, and data warehouses.
- For parents, assessment experience consistency means greater ease in locating information about their student and understanding report displays.

Increased cost efficiency. In addition to improving assessment experience consistency, multi-tenancy and interoperability offer the potential for significant cost savings and cost efficiencies for states and for vendors that leverage the assessment system components developed by the consortia. The Smarter Balanced consortium system includes a plan for states to select vendors that will host and administer the assessments being developed by the consortium. Regardless of content area, shared

Invitational Research Symposium on Science Assessment

knowledge and use of the system components being developed by the consortia can help vendors design and develop a delivery strategy that is both cost-efficient and compatible with these system components. In addition, should vendors decide to develop their own assessment delivery mechanisms, familiarity with the architecture and coding of the consortia systems will enable greater interoperability and compatibility between all systems that are ultimately put into place. Finally, the efficiency and security of using the consortia's systems offers the potential for greater competition and lower costs to deliver solutions based on its multi-tenancy architecture.

The long-term vision for RTTAP is that educators and developers in content areas beyond ELA and mathematics and those creating assessments for students with disabilities will be able to share the existing assessment development and delivery resources, rather than having to create and implement multiple, novel, testing approaches. At the same time, the ability to customize and develop state-specific modules will help those developing assessments to tailor components to their content area while still taking advantage of existing tools and resources. For example, science educators may be able to use the same system components as ELA and mathematics educators to develop online assessments that are aligned with the Next Generation Science Standards (NGSS). In this way, sharing these systems would allow science assessments to be supported by the same test delivery systems being developed for ELA and mathematics, rather than the science community having to invest the time and resources to develop their own delivery system.

Improved resource quality and collaboration. Both Smarter Balanced and PARCC are overseeing the development of digital libraries that will be accessible by educators, most likely through the online consortia portals. The Smarter Balanced library includes resources to interpret and make use of the summative and interim assessment data reports. It will also include interactive professional learning modules and subject- and grade-specific instructional modules, both of which will focus on formative assessment practices that support day-to-day instruction. Educators can use the library to steer their own professional learning by browsing and searching for resources that help them adopt practices that improve classroom instruction.

Because the libraries leverage multi-tenancy, they can be used by hundreds of thousands of educators in consortium states and districts. The libraries will benefit this large user base by including social features that create additional value. In particular, the libraries will enable users to submit resources, determine whether those resources should be published, and rate and comment on resources. The libraries will also enable educators from consortium states and districts to collaborate and share insights online. Smarter Balanced will periodically employ usage data to drive improvements in resources.

Increased market adoption of cost-efficient and effective plug-in architecture. Using multi-tenancy models that allow contributors to use the same platform and plug in their own components generates commonality among users and developers. When the multi-tenancy platform is open source, this commonality drives innovation *on top of* the platform. For example, Firefox and Chrome web

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browsers have plug-in architectures that allow innovative new features to be created by contributors at relatively low cost, creating very high value. Even without open-source licensing, the Apple App Store provides a common platform that permits innovative, high-value, low investment applications, or apps, to be created for many novel purposes. In fact, the overall smartphone app business is booming: According to Canalys, a market research organization, two of the leading mobile app stores, Google Play and Apple App store, currently offer more than 800,000 apps each to users (Canalys, 2013). These apps range from the simple (track how many steps you've taken as part of a fitness app) to the complex (search, find, and book a complete travel package) and are continuously reviewed and rated by users, thus weeding out weak offerings and increasing pressure on developers to create useful and effective apps. The Smarter Balanced assessment platform will also offer this plug-in approach, opening the door to low-cost yet useful educational app development across the country. The platform may also attract the attention of global app developers, which could lead to interesting app development of an international nature for K-12 education.

This type of innovation can serve as a market-organizing force, moving vendors away from competing with alternative platform technologies, to competing over innovative uses of the multi-tenancy platform.

To reiterate, this paper describes the design of the Smarter Balanced Assessment Consortium system architecture. A second paper will describe the PARCC system architecture, which will follow many of the same principles of design and will also be capable of supporting content areas beyond English language arts and mathematics².

Part II. How the Smarter Balanced System Components Benefit Stakeholders in Content Areas Beyond ELA and Mathematics

Smarter Balanced Assessment Consortium Architecture Overview

The Smarter Balanced system includes a digital library, a test creation system that includes an item bank and item and test authoring tools, a test administration platform, and a data warehouse and reporting system. See Figure 1. Each component is described in greater detail below, but in short, these four system components cover the entire process of online assessment development:

- The digital library will contain formative assessment resources, professional development modules, exemplar instructional modules, and collaboration functionality.
- The test creation system includes an item bank consisting of a collection of reviewed and approved selected-response, constructed-response, and technology-enhanced

² To receive notification of the release of the paper describing the PARCC system architecture, go to www.k12center.org and sign up for the K-12 Center news releases.

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performance items with which to create tests; and item and test authoring tools that allow educators and administrators to develop and select assessment items with which to create complete tests for students.

Smarter Balanced – System Architecture

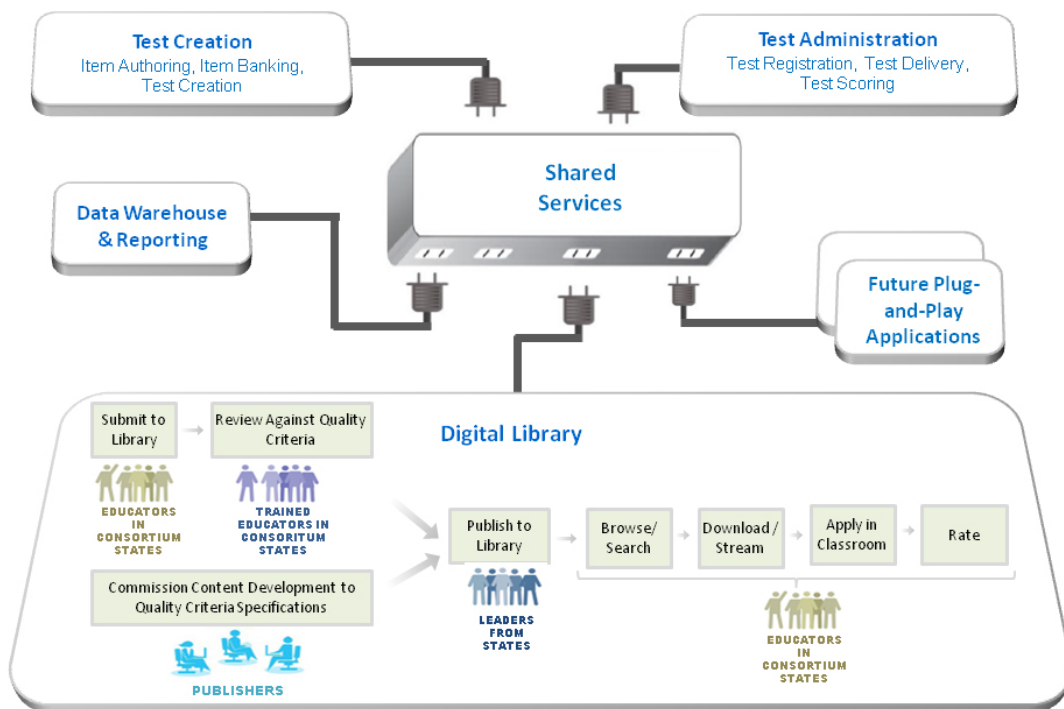


Figure 1. The Smarter Balanced system architecture.

Graphic courtesy of Amplify.

- The test administration platform manages student registration for tests, delivers tests securely to students, stores the responses, and coordinates delivery of the scores to the data warehouse. Smarter Balanced will build an open source test delivery engine that independent vendors can use for reference, or vendors can incorporate the open source code into their systems. However, all states will procure test delivery from these vendors rather than directly from Smarter Balanced.

Invitational Research Symposium on
Science Assessment

- The data warehouse and reporting system will store data generated by the test administration component along with additional relevant data and will generate a variety of report types for use by students, parents, educators, and administrators.

In terms of multi-tenancy and system architecture, all states will be able to access the system components online simultaneously, but student data, proprietary assessment items, assessments, and digital library resources will not be shared with other states, as shown in Figure 2.

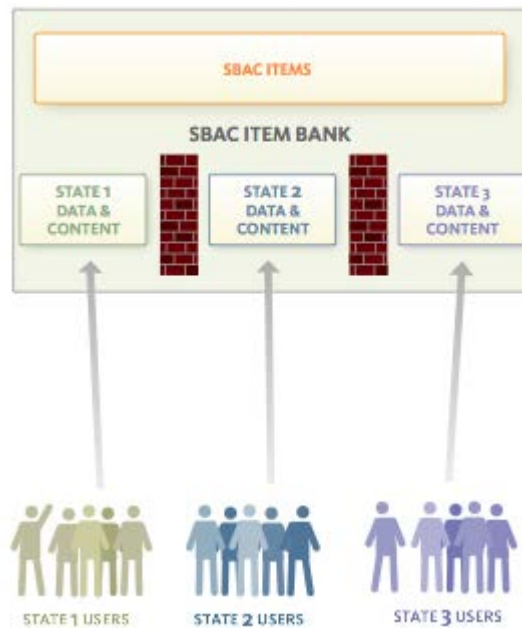


Figure 2. Resources available to state users in the Smarter Balanced item bank. Graphic source: Assessment System Architecture and Technology Phase 1 Report. January 9, 2012.

Invitational Research Symposium on Science Assessment

Figure 2 refers specifically to the item bank, which will contain assessment items developed by content experts and tied to content standards. Each of the four system components will offer similar degrees of access and data security for states and will be integrated fully with each other. Therefore, broad educator involvement in contributing standards, creating assessment items, contributing digital library content, and utilizing all system components is not only possible, but is critical to the integrity and usefulness of the system components over time.

It is important to note that states are not required to use all of the Smarter Balanced components, and flexibility will be built in to allow states to develop and attach their own item bank, for example, or add their own proprietary items, which are only accessible to that state. The exact parameters of these possibilities are currently being discussed and finalized by the consortia and the vendors involved.

A description of the four main Smarter Balanced system components and their relevance to science and other content areas follows, after which an overview is provided of how educators in content areas other than ELA and mathematics can leverage these system components in the future.

Digital library. Smarter Balanced has awarded a contract to oversee the development of their digital library. The primary contract goals are to (a) develop processes for evaluating and publishing high quality resources that are currently available in the field, (b) develop new best in class professional learning and instructional modules that reinforce balanced and formative assessment practices, (c) develop collaboration functionality that furthers professional learning, and (d) put in place a governance process that drives continuous improvement of resources.

Materials to be placed in the digital library will include existing royalty-free resources, such as those developed by educators within consortium states, as well as new materials developed under the digital library contract. The latter will include professional learning modules that help educators use evidence from the formative, interim, and summative assessments; subject and grade-specific modules that reflect exemplars formative assessment practices; and modules that help educators, parents, and students understand score reports.

All materials placed in the digital library will be screened against quality criteria by trained consortium educators. See Figure 3.

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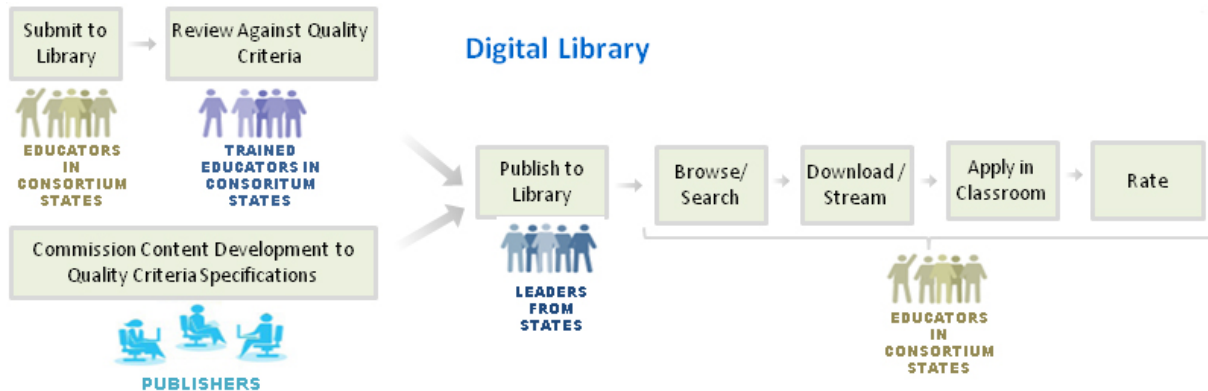


Figure 3. Process for screening items in the digital library.
Graphic courtesy of Amplify.

To ensure that all educators in member states know of these resources and how to use them, the contractor will train state leadership teams who will help promote the library to district leaders and regional service providers.

The digital library will follow select industry standards (e.g., the Learning Resource Metadata Initiative) so that it can interoperate with other content management systems that follow the same standards.

Of particular interest to educators in science and other content areas. ELA and mathematics resources will be focused on helping teachers align their teaching not only with the CCSS but with interdisciplinary approaches to teaching and assessment. For example, starting in grade 6, ELA standards include science-related concepts (see <http://www.corestandards.org/ELA-Literacy/RST/6-8>). Educators in science and other subjects will be able to use general resources such as those that model general formative assessment practices. In addition, science educators and others can contribute resources for possible publication in the digital library. In the longer-term, as the NGSS are released, the digital library could potentially include professional development (PD) modules for middle school science teachers on how to write classroom tasks that are both aligned with the NGSS and that support the CCSS.

Test creation: Item bank. The item bank will be tied directly to the item and test authoring tools and the test administration platform, which will be integrated into a single, seamless, user-friendly system. The item bank will perform the following tasks:

- store and retrieve assessment items
- store and retrieve metadata related to the assessment items (when the item was created and by whom, to which standard the item applies, etc.)
- Track item versions

Invitational Research Symposium on Science Assessment

- Track item revisions
- Provide a search and query capability

Of particular interest to educators in science and other content areas. Content area educators in all fields will be able to access and create assessment items for the Smarter Balanced item bank. There are no restrictions on content area with this system component. As with every system component, the item bank will ultimately be available as open source, meaning states can take the code and modify it to suit their needs if desired and even create their own item bank. There is also the possibility of developing a proprietary item bank for a particular state or content area and attaching it to the rest of the system for use with the item and test authoring tools, the test administration platform, and the data warehouse and reporting system. However, final details of the potential integration of state and consortium item banks is still being worked out by consortium leaders, so stay tuned for more information as the system components are further developed.

Test creation: Item and test authoring tools. These tools will provide an intuitive graphical interface for creating items and for creating test blueprints and will allow test developers to construct content that is aligned to content standards. The authoring tools will seamlessly interact with the item bank and test administration components in order to create consistently formatted items and tests across content areas.

Test developers will be able to create multiple-choice, constructed-response, and performance tasks with easy-to-use HTML editing tools in a fully online environment. The content created can be delivered through multiple test administration platforms, offering the flexibility needed to interact with a variety of vendor test delivery applications as needed.

Of particular interest to educators in science and other content areas. For educators of science and other content areas beyond ELA and mathematics, the item and test authoring tools were originally designed as an assessment delivery system with no restrictions on content area. As stated in the winning proposal, “The...application supports the development, review, storage, import, and export of both traditional and non-traditional item types and formats developed for a variety of purposes, across all grades and content areas” (Pacific Metrics, 2012, pp. 2-7). The RFP for Smarter Balanced includes the open source requirement for the item and test authoring tools, so the tools are expected to as flexible as the original delivery system.

The contractor will provide web-based training for Smarter Balanced stakeholders in the use of the item and test authoring tools as well as training guides to help users at all levels learn the functions of the system. In addition, the contractor will design self-training tutorial modules for each of the different users, such as item writer, artist, and administrator.

Test administration platform with adaptive technology readiness tool. The Smarter Balanced test administration platform will be open source and integrated with the other system components. The platform will provide vendors with the ability either to use the platform as it is designed for the Smarter

Invitational Research Symposium on Science Assessment

Balanced consortium or to modify the code to customize the platform for individual states. The test administration platform will perform the following tasks:

- Securely deliver assessments to students
- Store student responses
- Store additional information, such as time to responses, time to render tests for students, and so forth
- Deliver test items in the accessibility format required for the student

The delivered tests will offer the following tools to students at a minimum: a calculator, spell checker, and thesaurus; graphing tools; measurement tools; and formula charts. The tests will also support multiple response types, including selected-response, constructed-response, technology-enhanced items, and performance tasks. The test administration platform will allow students to be clustered by classes, programs, or other groupings as needed for the purposes of scheduling, monitoring, and reporting.

Of particular interest to educators in science and other content areas. The winning contractor's proposal specifically indicates that in addition to securely delivering Smarter Balanced ELA and mathematics tests, "...the system will provide the ability to add additional tests, specifying subject and grade availability (e.g., science), for secure delivery" (American Institutes for Research, 2012, p. 72). In addition, the architecture requirements include the ability to provide tools and tutorials to help students during the tests and to deliver items that have been translated into other languages. These enhancements will likely prove useful to assessment developers in all content areas. As indicated previously, it will be important for educators in science and other content areas to contribute items to the item bank in order for there to be a sufficient repository of content with which to develop and administer assessments in a particular content area.

Data warehouse and reporting system. A comprehensive data warehouse and reporting system will interoperate with the digital library and all of the other Smarter Balanced components. For example, the database and reporting system will be based on a relational database that will gather information from the test administration platform.

Types of reports. Users of the reporting system will be able to view summative and interim reports in a variety of types and styles, depending on their role and permissions (students, parents, teachers, administrators, at the state level and the consortium level). The specific reports are under still under development.

In addition, at the end of the first year of implementation, the consortium will use the data warehouse and reporting system to evaluate the quality of each of its items consistent with industry best practices. These analyses examine the performance of items across large groups of students to ensure that each item is free of bias and supports a fair and reliable test.

Invitational Research Symposium on Science Assessment

Of particular interest to educators in science and other content areas. The Smarter Balanced data warehouse and reporting system will also be released as open source. This means that the warehouse can support additional content; however, there must be relevant data on assessments in science, history, art, or any other field for useful reports to be developed and generated for these stakeholders.

The first beta test of the system was completed in May 2013 with a small group of users and a subset of reports. The system will go through revisions and is expected to be operational in November 2013. The next round of beta testing, which will be of the entire data warehouse and reporting system, will be in January 2014. As described below, there will be opportunities for educators in all content areas to participate in this important round of testing and development.

What Educators in Science and Other Content Areas Need to Know About Leveraging the Smarter Balanced System Components

As stated earlier, educator involvement in the development and use of all system components is essential to the usefulness of the components across the board. For example, a critical mass of assessment items in science (or history or art, etc.) must be created with an item and test authoring tools and contributed to an item bank for science administrators to be able to use the component to develop useful assessments for this content area. The potential benefit of using the Smarter Balanced system for this process is that science educators around the country can contribute assessment items to the item bank, and the items can be reviewed, rated, and modified by teams of science educators and content experts until they meet quality standards. In this way, the growth of the item bank can be accelerated and costs minimized; however, there needs to be a sufficient number of representatives from science in the review and evaluation process to ensure its success. Although states will continue to have a variety of reporting options available to them, they may elect to leverage the Smarter Balanced data warehouse and reporting system to be able to provide informative and useful reports for science.

Use of the digital library and its quality control processes can lead to both greater consistency and cost-efficiency in the development of much needed implementation resources such as professional development and instructional modules. The collaboration tools within the digital library allow educators from across the country to discuss, adapt, and improve these shared resources. A common tagging scheme is needed to ensure that the resources can be quickly located to meet specific needs.

Standards Must Come First

The system components will not be as useful as they could be to educators in areas beyond ELA and mathematics if there are no content area standards in the system to form the foundation of assessments in those areas. Thus the first step for consortia educators is to agree on the content standards that will be used for their state. Then, if needed, an organization called Jes & Co is available to

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help adapt those standards to the digital formats needed to include them in the Smarter Balanced system so the standards can be published, shared, and accessed by other educators in the state and across the consortium. “The Achievement Standards Network, operated by JES & Co., maintains an open database of all 50 states' existing standards, plus the Common Core, plus those published by the American Association for the Advancement of Science and many others” (Redd, 2012, para 10).

Opportunities to Participate

Many of the contractors developing the system components for Smarter Balanced will be offering virtual and live training and education sessions in the use of the components. The consortium understands that educators and administrators will need time and practice with the new system components, so the interval between the launch of the system and the time when useful data is available is an excellent time for educators in science and other content areas to get on board with the use of the system components. For more information about these sessions, please contact your state education agency.

There will also be networks of educators in various states who will identify and vet resources for the digital library. For more information about these opportunities, please visit <http://www.smarterbalanced.org>.

Conclusion

Publicity surrounding the consortia and RTTAP often touts the next generation of K-12 assessments, but RTTAP also promotes and supports the next generation of educators, administrators, and developers. The new assessment professional development and instructional tools represent a leap forward in our ability to create, find, and access the best-of-the-best in teaching and learning. Making the most of these new technology-enhanced assessment tools is a path to a higher quality instructional experience and a more authentic and consistent assessment experience for students. In addition, the RTTAP process aligns with and complements the changes we are already making in our personal and professional lives with regards to finding, accessing, sharing, and using information to improve our lives.

Many of us have already used Google to search for such things as *the best apps for preschoolers* or perhaps *the best gifts for golfers*, and we have carefully perused the customer reviews of a product before making a choice between brands or models. Just as we can now find that specific book, movie, or rare type of tea we are searching for (instead of being confined to the choices at a local store), we can now find the most effective resources or items to teach a specific concept to our students and effectively assess their learning or to help a teacher learn a new skill online. Just as online publishing and YouTube allow writers and artists to promote themselves and be discovered, educators and developers can produce resources at low cost and offer them for evaluation and use through the consortia libraries. Screening and user feedback and evaluation ensure ongoing pressure to develop more useful resources, leading to a collection of best practices for the K-12 environment.

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Clearly, to support this process efficiently and in a cost-effective manner, it is in our best interest to participate in the development and use of the consortia system components, rather than continue to go our own way in our current, separate silos of teaching and assessment methodology. Next generation educators and developers in all content areas now have an opportunity to access a much broader pool of talent and expertise 24 hours a day, to cull the best of their work, and to adapt it to specific local needs and interests, all to prepare our students for college and career more effectively than ever before.

Author Note


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Invitational Research Symposium on
Science Assessment

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The Center for K–12 Assessment & Performance Management at ETS creates timely events where conversations regarding new assessment challenges can take place, and publishes and disseminates the best thinking and research on the range of measurement issues facing national, state and local decision makers.

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