

CompetencyWorks ISSUE BRIEF

Re-Engineering Information Technology

*Design Considerations for
Competency Education*

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You can learn more about competency education at CompetencyWorks.org as well as links and materials for all the resources mentioned in the paper on the [Competency-Based Pathways wiki](#).

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GETTING AHEAD: Mature IT for Competency Education

By Susan Patrick

President and CEO of the International Association for K-12 Online Learning

We are past the tipping point. Online and blended learning have become an essential part of America's education system, expanding educational options for students and enabling personalization. Most importantly, digital learning challenges the lock-step, batch-processing, and labeling of students in our schools. Students can and want to progress at their own pace, demonstrating their knowledge, collaborating with experts, teachers, tutors and other students, taking the time they need to master new concepts and skills. The result is a growing demand for student-centered, transformative digital learning using competency education as the underpinning and central focus on student learning.

During the last decade, competency education has taken root in our country. Over two-thirds of our states have adopted policies that enable credits to be awarded based on proficiency in a subject. Districts are showing results when they embrace a more personalized, competency-based model. Schools are exploring new and powerful ways to design around proficiency. Competency education may take place in traditional classrooms, in online courses, or in blended learning environments. Our schools are pushing toward a more flexible education system that can respond to the dramatically diverse needs of our children; however, the policies and infrastructure within our education system are built upon the batch-processing, factory model that continues to chug along producing low achievement and huge gaps in students' knowledge and skills, with grade-based variances covering up seriously low attainment.

It's time to create the upward trajectory and crush the curve. The old grading "curve" by definition assumes divergent expectations across a cohort of kids. Competency education instead creates a slope of high expectations for each child—an upward trajectory showing accomplishments and skills for success and readiness for college and careers in a global economy. Capturing each student's profile as they progress along the trajectory, upward and onward, over time, must be captured in the IT systems, as well. Every student is guided on an upward trajectory. The student's proficiency pathway means each student is moving upward and building skills and knowledge on their own pathway through mastery of standards.

Furthermore, our information systems need to do more than act as electronic grade books with an end-of-year test. We need to build smart information technology (IT) systems that chart levels of proficiency, compile portfolios of student work, offer pathways to competency, and capture meaningful assessment down to the level of the academic standard. We can't afford to continue investing in information systems that support the top-down, linear, time-based model. It is important that as a country, at the school, district, state, and federal levels, we design—and demand—IT systems and products that support competency-based education.

Competency Education Requires New IT Solutions

Competency education is student-centric, personalizing student progress so that every child has adequate time and support to reach proficiency every step of the way. So too must the IT system be student-centric, academic standards-based in its organization of data. Students can learn in different ways at different times. School designs

and operations will become more innovative and adaptable, responding to student needs by providing greater services and options. Competency education fundamentally changes the way the educational enterprise is organized around the student needs, and thus must have a dynamic IT system to support it.

The current IT systems are designed around three principles that are at odds with the emerging models of education. First, learning isn't always linear. The traditional model of education, and our current IT systems, assumes that students follow a linear progression to high school graduation. However, the more we learn about learning, the more we understand that learning is multidimensional. Students may vary in how they progress across the different academic disciplines. Their pace may slow down as they dive deep into a topic or need to spend more time to understand. High student mobility means that there will always be students with gaps that need adaptive tests to find the holes in their knowledge and skills. They will require support for addressing the gaps, taking a step backwards before they can go forward on an accelerated learning path. The IT systems need to hold the data to highlight exact levels of proficiency to the standard for each student over time.

Second, compliance diverts attention away from student learning. Federal policy, in the form of No Child Left Behind, has driven most of today's education IT systems with its top-down, school-based accountability. Efforts to create growth models move in the right direction but still emphasize cohorts and lumping kids in age-based structures. The current IT systems were built around state and school accountability policy rather than to fine-tune learning for students. Measuring schools is important, but it should be done using real-time, student-centered proficiency data accumulated from the ground up.

Third, standardization of time, bell schedules, and school calendars constrains innovation and responsiveness. Much of the education policy and school-based IT follows antiquated assumptions about locked in seat-time. Annual calendars, semester-based courses, and daily schedules define students' learning experiences. Data systems are built around time.

Competency education requires IT systems to be organized around student-centered learning, competency attainment, multiple pathways, and systems of assessments. With student profiles of standards, competencies, skills and proficiency levels in the center, an IT system can enable schools, districts, and states to roll student-level data up to monitor progress and fulfill state, district, and school accountability functions. The new IT solutions will need to have four elements in place.

#1: IT systems are designed with student profiles and standards-based, personalized learning plans.

Competency education depends on learning progressions made up of competencies. Competencies and their learning targets are built upon academic standards with a heavy emphasis on application and transferability of skills. Each student has a profile with an individualized learning plan that shows how they are progressing and what they need to do (or have done) to demonstrate their proficiency. In the ideal, the information technology supports student profiles and an e-portfolio system of demonstrated student work.

#2: Rich data on student learning enables robust continuous improvement.

Competency education IT solutions will generate student-level data about progress in reaching proficiency on specific competencies and standards. As our education system builds analytic capacity, we will be able to benchmark how long it takes students to master specific standards using different instructional approaches.

Student learning can be benchmarked using outcomes-based, performance metrics. Rich analysis can support improving teacher effectiveness, collaborative approaches, continuous improvement at the system level, and deployment of resources.

But this requires unique student, standards-based, proficiency-level data over time. No more wiping the student database clean at the end of the year. In a competency education system, the analytical capacity of districts and schools to use “big data” becomes more important than ever. The focus of conversation at the district and school levels centers on learning, and learning only.

- Upon entry, what was the student’s level of proficiency, down to the standard level? What exactly did the student know and where were the gaps?
- What were the time-bound goals for student learning based on their student profile? What was the speed to proficiency?
- How many students were we able to get on track? How many students are advancing more rapidly than the “teacher-pace”?
- What content resources, interventions, and student supports were provided to the student in the learning process?
- How are schools doing comparatively? Are there some schools that are more effective in helping students accelerate their learning to get back on track?
- How effective are teachers in facilitating learning? For special populations? On specific standards? How can we strengthen the effectiveness of teachers, individually and collaboratively?

#3: Student-centered systems require student-centered accountability systems focused on progress in learning.

Our current statewide information systems have been attempting to improve school performance through a clumsy top-down, untimely system that has increased awareness of the challenge our country faces but which offers limited data that can be of use in driving improvement. An analogy would be to think of checking the oil in a 1950s jalopy once a year. Our dipstick approach to measuring educational success is weak. Even new growth models often group students in age-based cohorts and rely on once-a-year testing. We need accountability systems that examine student-level proficiency data, collect productivity of amount of learning per unit of time, and analyze patterns of individual student growth over time.

In the past decade, accountability and the investments in data systems to support accountability have been generally structured as a governance function for compliance. This requires information systems to hold demographic data, student counts, attendance, grade point average, achievement levels, assessment results, and credits. In the competency education models emerging rapidly across the United States, the design and architecture of the information systems are flipped to become student-centered and to support student progression through identified sets of competencies.

With IT systems designed around student profiles, it becomes possible to look at school accountability by rolling the data up from the student level. We will need to learn to generate a flow of data that allows schools, districts, and states to understand a variety of patterns and trends, keeping an eye on ensuring that our most underserved students are advancing and advancing at an accelerated pace.

#4: IT enterprise architecture requires interoperability, accessibility, and interfaces.

The new IT architecture will require integration of the different teaching and learning systems: student profiles, content and assessment, professional development, intervention tools, and tutoring and support systems. The more effectively these work together, the more valuable the feedback on how to help students advance and the more time teachers have to facilitate learning. With transparency and choice, students can increasingly become drivers of their own education.

We'll need to adhere to interoperability and technology standards that enable sharing of data. Interoperability standards and robust application programming interfaces (APIs) are needed to create a well-developed, enterprise-wide IT system. In addition, we need to make it easier for teachers and students to access the right content, print and digital, at the right time. This requires content management systems tied to assessment engines, using learning analytics with individual student profiles. Finally, schools need flexibility in accessing content and applications across a variety of technologies and platforms.

There is no easy solution to our competency education IT challenge. The current educational IT already has too many disparate systems, cobbled and patched together. There is no "one size fits all" or off-the-shelf IT solution for implementing a systemic approach to competency education. Tough decisions will have to be made. Do we continue patching together information systems with content systems, data systems, and learning management systems that are not designed around individual student competency data? Do we start designing from scratch, or do we find solutions across systems?

This is why an enterprise architecture approach is needed for competency education IT. Today's mismatched IT systems are needed to adaptively measure complex learning environments, but they have poor alignment to competency education's student-centered, competency-based methodology.

The bottom line is that the new IT solutions need to make it easier for educators to support student progress. Grounded in real-time data, the IT system can enable our front-line educators to make informed decisions about personalized, rapid, differentiated instruction and support. With students, their student profile and personalized learning planning at the core of the IT system, continuous improvement and accountability can be aligned to transform our education system into a system of learning.

In the following paper "Re-Engineering Information Technology: Design Considerations for Competency Education," author Liz Glowa has courageously tackled these issues and more. After outlining the basics of what an IT system needs to do to support competency education, Glowa explores the facets of designing a system enterprise architecture, components, and capabilities. The issues and initiatives addressing interoperability, accessibility, and interface are reviewed and complemented by an in-depth appendix.

This paper is designed to drive further conversations to accelerate the development of robust information systems to support competency education. Please pick and choose among the sections that pertain to your role and use this paper to advance the development of student-centered IT systems in your school, district, and state.

RE-ENGINEERING INFORMATION TECHNOLOGY: DESIGN CONSIDERATIONS FOR COMPETENCY EDUCATION

I. Introduction

At the core of competency education is student demonstration of learning. Ideally in competency education, learning is along a progression of competencies that include a) clearly articulated and granular learning targets for what students must be able to “know and do,” b) clear rubrics for how students will demonstrate mastery at each stage, c) multiple ways for students to access content and demonstrate mastery, and d) dashboards with the data showing the level of proficiency or gaps at each stage along the trajectory. Each student has, in effect, their own personalized learning plan with progress made by demonstrating mastery of competencies.

Competency-based learning is fundamental to the design of new learning models that are student-centered and personalized. Students can learn anywhere and anytime, including through formal and informal learning experiences such as internships, research with museums, work-study experiences, and then progress through competencies as they are attained. While competency-based learning and standards-based learning have been important concepts for student-centered learning for decades, not until recently did the capability for intelligent information systems—content management systems, learning management platforms, student information systems, e-portfolio systems, and competency-based grade book programs—exist to help manage the data on how students demonstrate proficiency along a learning trajectory based on competencies. Most information systems have been developed for teacher-centric and course-based instructional models, rather than student-centered, competency-based learning models and were designed to meet the requirements of top-down accountability compliance models.

Accountability and the data systems to support accountability are generally structured as a governance function that requires information systems to hold demographic data, student counts, attendance, grade

COMPETENCY EDUCATION is rooted in the notion that education is about mastering a set of skills and knowledge, not just moving through a curriculum. In competency education, students keep working on specific skills or knowledge until they can demonstrate their understanding and ability to apply them; they then move to the next material while continuing to use what they have already learned. Students cannot advance simply by showing up to class on a sufficient number of days and earning a grade just above failing. Instead they must meet standards (also known as competencies, performance objectives, or learning targets) at a predetermined level of proficiency.

– *Making Mastery Work: A Close-Up View of Competency Education*¹

point averages, achievement levels, assessment results, and credits. In the competency education models emerging rapidly across the United States, the design and architecture of the information systems are flipped to become student-centered and to support student progression through identified sets of competencies.

Technical characteristics of this student-centered approach that are built into the information systems include a) providing transparency into what students know and need to accomplish, b) robust user tracking and reporting of performance, c) differentiated instruction and curriculum, and d) options on how students can demonstrate learning. In addition, the information systems are designed to support the multiple functions and responsibilities of the education system to support student attainment of competencies.

There is no perfect competency-based information system at this time. Nor is there a single approach to designing competencies or implementing competency education. In some schools, competencies are high-level statements with multiple learning standards, learning objectives/targets, and assessment activities. In other schools, competencies are numerous, almost similar to standards. Consistent across all of the organizations interviewed for this paper is the concept that a competency includes the application and creation of knowledge, along with the development of important skills and dispositions, and that progress is measured in multiple ways.

The early innovators developed their own information systems with limited budgets or resources. Some retrofitted products or patched together systems to meet their clients' needs, and for the most part they did not consider interoperability in the design considerations. We are in the midst of a storm of new product development to support Race to the Top and Common Core State Standards implementation; this provides an excellent opportunity to move from time-based systems to competency- and performance-based, student-centric systems. The advancements in information technology, as well as the concerted efforts to align the field for interoperability, support better design options.

This paper demonstrates the importance of analyzing and examining our knowledge of what makes up an effective competency-based information system. While designing competency education systems, it is important to keep student learning at the core, to incorporate interoperability principles, and to use an enterprise architecture approach that enables schools and districts to effectively manage their institutions. These systems need to be able to communicate, to supply the data and support that administrators, educators, and students need in order to know exactly how individual students are progressing based on clear competencies.

Based on interviews and research, the ideas here build upon the information systems developed by competency education innovators, best practices of systemic approaches to information management, and emerging opportunities. This paper is designed for readers to find the sections that are of most interest to them in their role and be used to catalyze strategies, support new competency-based instructional models, and inform decision making for continuous improvement. Please consider this paper as an opportunity to catalyze conversations in your organization and networks about how we can design IT systems with student learning at their core.

II. Understanding Competency Education

At the core of competency education is the concept that students advance “not just by demonstrating growth in learning, but by demonstrating competency,”² and that each student progresses at a personalized pace with adequate time and support to promote mastery. In 2011, iNACOL convened innovators from across the nation to develop a working definition of competency-based learning approaches. The definition of competency education has five parts:

- Students advance upon mastery.
- Competencies include explicit, measurable, transferable learning objectives that empower students.
- Assessment is meaningful and a positive learning experience for students.
- Students receive timely, differentiated support based on their individual learning needs.
- Learning outcomes emphasize competencies that include application and creation of knowledge along with the development of important skills and dispositions.

A multifaceted approach to education is essential for teachers, schools, and districts to effectively enable students to progress toward competency. Ideally, schools that implement competency education should have these capabilities:

- **Personalized Learning Plan:** Students, teachers, parents, and school administrative staff should have real-time access to information about which competencies a student has attained and which competencies are yet to be mastered within a personalized learning plan. The competencies should include explicit, measurable, transferable learning objectives.
- **Choice:** Teachers and students should be able to select from high-quality curricular resources, strategies, and assessments aligned to the objective level of the competencies, and be able to use these in a variety of digital and non-digital settings.
- **Data:** Educators should have easy access to formative and summative performance data on their students, as well as data on the usage and rating of the materials and content. They should then be able to use this data easily to provide timely, differentiated support to each student.
- **Intervention:** Teachers and school leaders should have point-in-time and longitudinal data views of individual student progress and of class and whole school progress on the competencies and the associated learning objectives, rubrics, and tasks. School and district leaders should have access to analytics that can help them discern when a teacher or school may need assistance.
- **Support:** Professional development and support for students, parents, teachers, school leaders, and district leaders is essential. Professional development should include understanding competencies/learning targets and reporting on competency attainment, the pedagogy of competency education including pacing and policies, implementing effective communication strategies, and training on the information systems. Support would include technical support as well as collaborative learning communities.



You can learn more about competency education at [CompetencyWorks.org](https://www.competencyworks.org) as well as links and materials for all the resources mentioned in the paper on the [Competency-Based Pathways wiki](#).

III. Designing an Information Technology Conceptual Architecture for Competency Education

In just the way that a house needs a strong foundation, IT systems need a strong architecture upon which they can be built. In this section, the elements of the conceptual architecture will be described, beginning with a look at scenarios to understand how competency education differs from the current model of education. From there, the capabilities that will be needed in the IT system are identified and examined.

A. Scenarios

To better understand what a competency education IT framework could encompass, let's look more closely at some scenarios that describe what students, parents, and educators might want to be able to do as part of their educational system. Without the integration of robust, standards-based IT systems, it would be challenging for an institution to fully implement these scenarios.

#1: Maria is a 4th grader who performs inconsistently in school, excelling in math but reading at 2nd grade level. The district has aligned its materials, assessments, and exemplary lessons to state standards, including the Common Core State Standards. Maria's teachers need a dashboard that will help them to:

- See how Maria is doing, review appropriate materials and strategies, and see if there are any other students in her classes that have a similar profile.
- Assign materials, tasks, and assessments aligned at an objective level for the standards Maria needs to master, using a system that recommends appropriate resources and strategies. Use the same dashboard screen to assign these materials, tasks, and assessments to other students with a similar profile.
- Track Maria's daily performance and progress on these tasks and the associated objectives/competencies. The system should accept multiple examples of evidence of learning and be able to include progress data for tasks and assessments not within the system.
- Keep Maria's Personalized Learning Plan updated, as new assessments are graded, to show her progress on objectives/competencies and revise the competency rating with the higher proficiency level as the new data is added.
- Produce reports to inform Maria and her parents of the work to be completed, her progress on that work, and her current competency attainment on her Personalized Learning Plan.

#2: Joe is preparing to take the state assessment in algebra for the third time. He and his parents ask his teacher to help him strengthen his skills in the areas in which he is weak. Together they review the dashboard that shows Joe's progression in building competencies in algebra. Joe's teacher identifies that Joe is missing a prerequisite skill (representing and analyzing quantitative relationships between dependent and independent variables; CCSS.Math.Content.6.EE.C) that is impacting his success in creating equations that describe numbers or relationships (CCSS.Math.Content.HSA-CED.A). She assigns some resources to Joe's dashboard that help reteach the prerequisite concepts and move him forward toward mastery of the high school algebra standards. Joe also adds some additional resources related to CCSS.Math.Content.HSA-CED.A.

#3: Fascinated by government and politics, Hia recently become a Congressional Intern. She has been given permission to receive credit for the required high school government course if she can demonstrate her competency of the state government standards. After reviewing the competencies and learning objectives with her sponsor at school and her supervisor, she has been collecting artifacts that demonstrate application of her knowledge into an e-portfolio and is putting together a presentation to demonstrate her competence. Her school and workplace mentors will provide feedback on the evidence of learning and her presentation before she formally presents to the schools performance assessment team.

#4: Principal Leary is concerned about the number of students who are not doing well on the state assessments. He has pulled together his team to do an in-depth review of how students are doing and create a plan that ensures that students progress. He looks to their competency education system to:

- Identify if the students who are reaching proficiency are being assigned different strategies/materials from those students who aren't proficient or who have other commonalities.
- Use a demographic analysis of the students not progressing to see if the school needs to strengthen its instructional efforts or address issues related to the school.
- View the students who are not proficient on the state assessments in each discipline, drilling down into the standards to see if there are key concepts that students are not learning that are holding them back.
- Examine if there are some teachers who are able to help students progress more rapidly, teach the key concepts, or work with subgroups of students.
- Review lessons, assessments, and resources to ensure that they are aligned with the Common Core and state standards and address any gaps.

#5: Howard School District administration wants to know the district's effectiveness in helping students meet the Common Core and state standards. They begin by looking at student progression on competency attainment over multiple years, disaggregating data by student demographics, school, teacher, and course. They are taking a special look at middle school math to better understand the drop in 8th grade test scores in mathematics by analyzing the mathematics competency data to determine when students start to progress at a slower or more uneven rate and then examining that data in depth in order to make improvements so students will enter high school on track. In addition, they are exploring how well the district's resources are aligned to standards, which resources are being used, by whom, how often, and if there is any correlation between the use of the materials and student performance. They want to determine if there are any gaps in how the standards are being covered within the curriculum and courses.

At the center of all of these scenarios is the focus on student mastery of competencies through a variety of personalized tools, resources, and strategies and the use of robust data reporting and technology support to enable personalized, data-driven instruction. The central elements described in the scenarios form a simple logical relationship for student instruction, as represented in Figure 1.

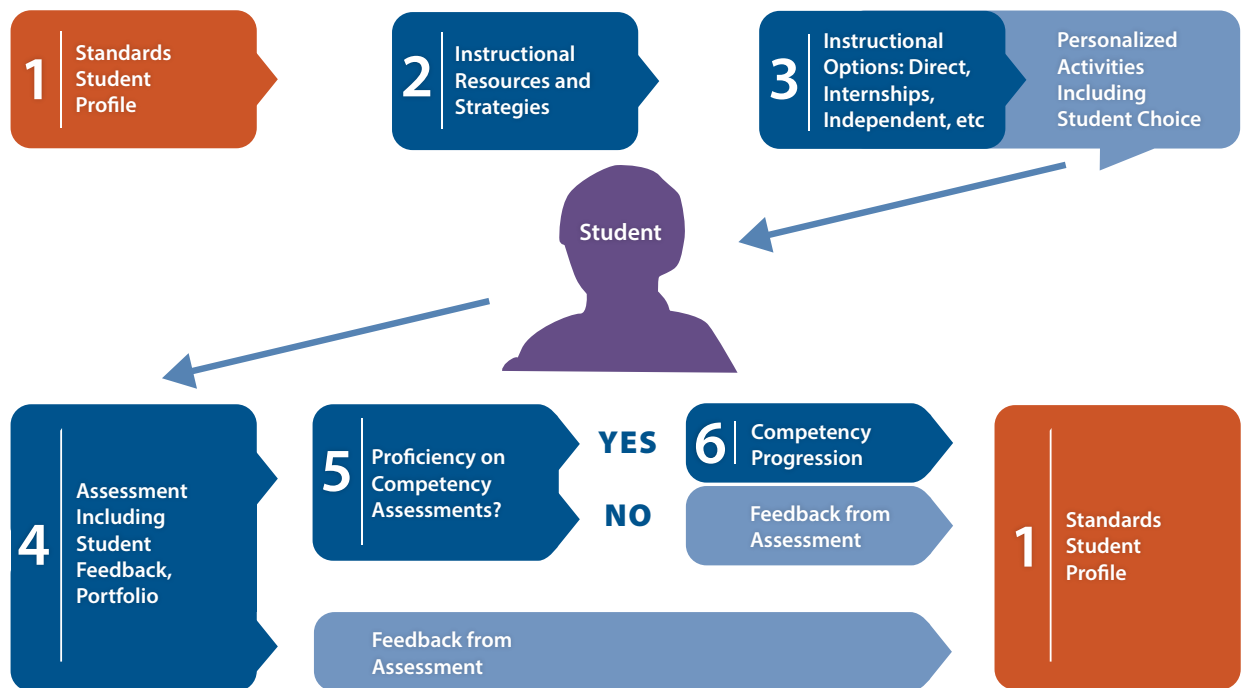


Figure 1. Key Elements of a Competency-Based Student Instructional Cycle

Three things differentiate the competency-based model from the traditional model.

1. Instruction is based on a profile of the students' progress on mastery of clearly defined competencies.
2. The cycle continues if students do not demonstrate proficiency.
3. It is transparent to students.

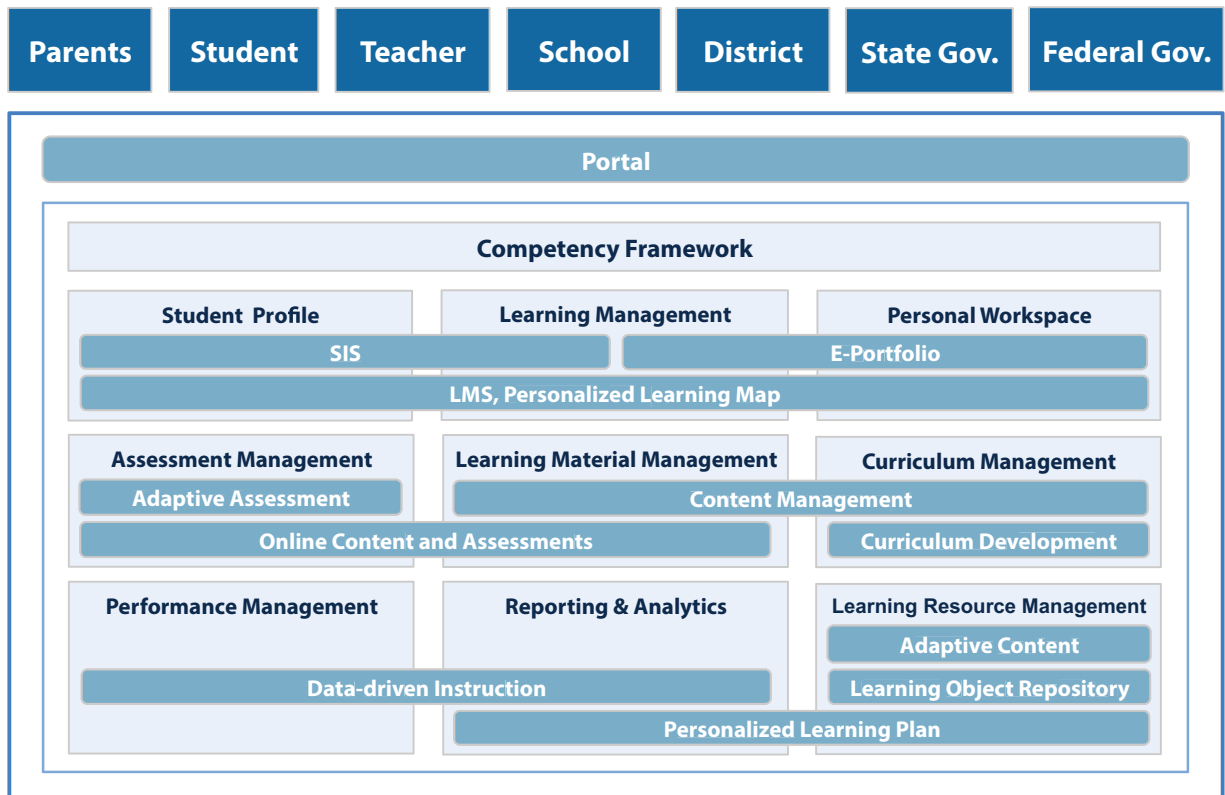
This instructional cycle for competency education serves as the foundation for understanding the other information systems needed to support that cycle. In competency education, the student instructional component is one piece of a more encompassing systems approach that includes components needed for everyone involved in the educational process.

An ideal conceptual architecture would include systems to support these core functional capabilities:

- Competency Framework
- Student Profile
- Learning Management
- Personal Workspace
- Assessment Management
- Learning Materials Management
- Curriculum Management
- Performance Management
- Reporting and Analytics
- Learning Resources Management

This would require a comprehensive approach to the required information technology systems, data standards, and interoperability standards. Moving robust, consistent, longitudinal, and real-time data and resources seamlessly across multiple systems is essential to a competency-based information technology framework. A layered approach to the core functions and information technologies should be considered due to the complexity of the tasks. A competency framework is visualized in Figure 2. This framework, including additional technology support systems and requirements, will be described in the next section.

Competency Framework



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Figure 2. Competency Framework

B. Different Users, Different Needs

Users of competency-based IT systems will have different views of information, dependent upon the user's role and the design of the IT system. What is consistent across all of the views is the need to enable student mastery of competencies through a personalized learning path, as well as robust competency reporting through the seamless integration of the systems that support these functions, including a single sign-on entry point.

For students, a competency system would include a personalized learning plan that details their progress across competencies and other accountability measures. It would also provide access to appropriate resources and assessments in order to support advancement toward mastery, enabling them to take more responsibility for demonstrating progress. Information technologies would support the digital content in online learning, assessments, and e-portfolio development.

For parents or mentors, a competency system would include access to meaningful reports on their student's progress and access to appropriate resources to support the student in advancing upon mastery.

For teachers, a competency system would provide a dashboard that includes competency and other relevant performance data for their students. From this dashboard, teachers could enter performance data and search for and review materials and strategies that would be appropriate for students based on their profiles. The system would be designed to recognize and highlight opportunities for intervention and present this information in a simple user interface. Ideally, it would include proactive messaging and alerting capabilities that specifically identify issues requiring teacher or administrator attention. From this dashboard, teachers could also assign materials, tasks, and assessments to students and monitor daily performance and progress on these tasks, as well as the associated objectives/competencies. Information technologies would support online instruction, assessments, and data collection.

For school or district leaders, a competency system would provide a dashboard that includes competency and other relevant performance data for every student, as well as access to aligned resources and assessments. This system would support profile reporting on individual students, groups, classes, schools, and districts, in real time and longitudinally. Profile views would include progress on the competencies, associated learning objectives, and the assessment tasks and rubrics associated with the objectives. Additional analytics would allow the leaders to view whether there were any competency alignment gaps in the curriculum or in how teachers are assigning resources to support student competency attainment and analyses of effective strategies and resources. It would help them discern when a teacher or school needs assistance.

For program directors, such as for special education or ELL, a competency system would provide a dashboard that includes competency and other relevant performance data for every student within the target population. This system would support reporting on individual student profiles and target population profiles, by school and district, in real time and longitudinally. These reports would include progress on the competencies, associated learning objectives, and the assessment tasks and rubrics associated with the objectives.

At the state level, for those that have adopted a competency education approach, the system would provide a dashboard that includes competency and other relevant performance data for every student within the state, with reports by school, district, and target population. This data might be in the form of course completion based on competency attainment, which is currently the practice in states that are implementing competency attainment for graduation. In the future, states may move to monitoring competency mastery by

competency progression, instead of by course completion. Or they will monitor competency mastery by both competency progression and course completion. Some states are moving toward providing educator access to data reports on student progress aligned to the Common Core and/or state standards. In addition, they have aligned resources to these standards so that teachers can search for resources based on student progress on standards. For these states, additional analytic reports would allow the state to determine whether there were any competency alignment gaps in the resources available throughout the state and to view reports on usage and ratings of the resources by the end users.

C. A Competency-Based Education Conceptual Architecture

To meet all of these needs, a competency-based education system should include these core functional capabilities:

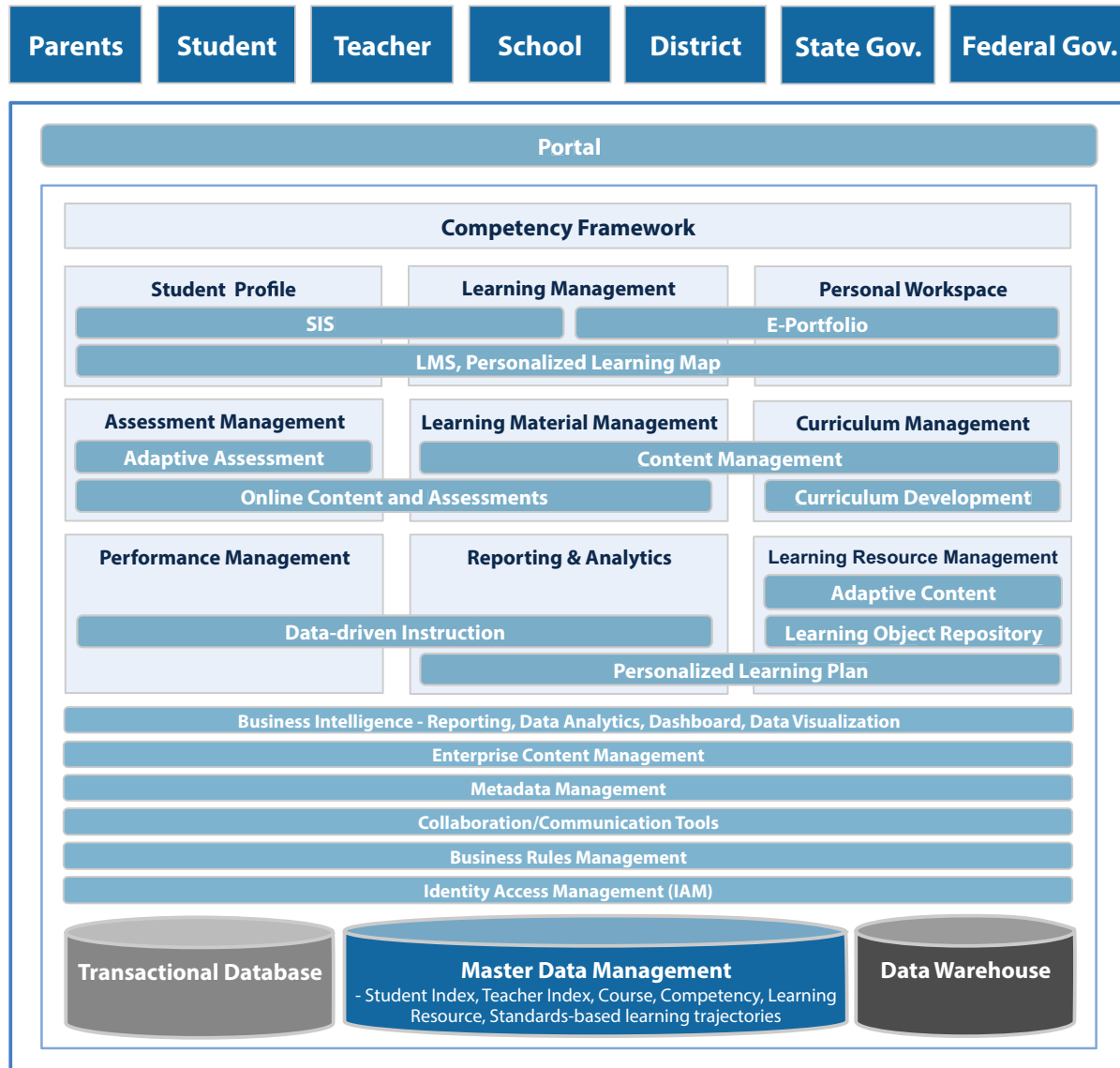
- Competency Framework
- Student Profile
- Learning Management
- Personal Workspace
- Assessment Management
- Learning Materials Management
- Curriculum Management
- Performance Management
- Reporting and Analytics
- Learning Resources Management

These core functional capabilities are an organization's distinct and differentiated business capabilities that are independent of the organization's structure, systems, processes, people, or domains. This business capability model forms the top of the business process hierarchy that can then be extended and detailed as deeply as needed to solve specific business problems.

To support the core functional capabilities, an organization needs enabling IT applications, as represented in Figure 3. These applications are the types of technologies that support the core functions of a competency education system. In competency education, most organizations build out the applications for the instructional and data needs by combining one or more homegrown IT systems and/or commercial off-the-shelf programs. Integrating these systems works only if there is a strong set of interoperability standards, allowing the systems to "talk to one another" to perform the needed functionality.

The core functional capabilities pictured in Figure 3 would enable a robust competency education system.

Competency-Based Education Conceptual Architecture



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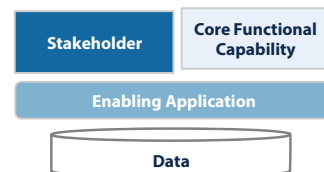


Figure 3. Competency-Based Education Conceptual Architecture

Competency Framework

The Competency Framework, used by many of the following core functions, is the competency taxonomy. It comprises the specific competencies and learning targets that have been designed by state, district, or schools.

Student Profile

The purpose of this capability is to integrate all relevant points of information related to students into student profiles and make it accessible to users and stakeholders when and where it is needed. These data points currently exist in numerous pockets, such as student assessment data in an SIS (Student Information System), competency progress records in a competency reporting system, user profiles in an LMS (Learning Management System), or a transcript in a records-keeping system. Rarely are all pieces of information on the student's history, progress, and learning pathway available in the same place. The student profile function integrates a full set of available data on the student and makes it available to other information systems. The Personal Workspace (below) would provide the interface for the aggregated data across the architecture and present it seamlessly in a dashboard.

Learning Management

Learning Management ties together the components of curriculum, instruction, communication, assessments, e-portfolios, student information, and other features to manage and facilitate adaptive learning.

Personal Workspace

The Personal Workspace provides the intuitive interface for the users (teachers, students, administrators) to view and manage their data, content, lesson plans, accomplishments, etc. It supports an aggregated view of all relevant information to provide a holistic view of each user's learning plan and progress. The application is usually a dashboard, which provides a seamless user experience that ties together the various functional capabilities and sources of information that enable the competency-based model.

Assessment Management

Assessment Management includes the ability to:

- Plan and execute the administering of assessments online,
- Record assessment results from offline assessments, and
- Provide that information where needed, such as to enable personalized learning.

Assessments are typically taken in summative or formative fashion, and both require specific capabilities. In competency education, Assessment Management systems support the ability to record progress on competency assessments with a longitudinal perspective in which students can be reassessed on a competency. Assessment Management also supports the ability to tie assessment data to the learning plan and the curriculum to enable competency-based learning.

To keep up with the pace of change in technology, we need to securely architect our systems for interoperability and openness from conception. We need to have common standards and more rapidly share the lessons learned by early adopters. We need to produce better content and data, and present it through multiple channels in a program and device-agnostic way. We need to adopt a coordinated approach to ensure privacy and security in a digital age.

– *Digital Government: Building a 21st Century Platform to Better Serve the American People*³

Learning Material Management

Learning Material Management enables the processes around gathering applicable content and making it available to those who need it. It is akin to the processes supported by a content management system, but it enables the requirements specific to K–12 education content. This also includes the function of interfacing with financial or procurement systems, as necessary, to acquire external content.

Curriculum Management

Curriculum Management encompasses the administrative processes and procedures involved in maintaining accurate, up-to-date information about what curriculum a school district offers. The framework is typically grounded in agreed upon educational standards, such as the Common Core State Standards. Curriculum Management systems enable curriculum developers and other administrators to build, refine, and modify the specifics of a given curriculum in order to share it with stakeholders or other systems. Curriculum Management has a strong relationship to all other core competency education capabilities, particularly Learning Material and Resource Management, in its sharing and storing of learning resources.

Performance Management

Performance Management in this context is focused on optimizing organizational performance and promoting individual growth and development within the competency education framework. Performance Management includes the analysis of data on student progress and the use of resources to support teachers and principals in improving performance. Teachers use the analysis to reflect and adjust their own practice, structure collaboration with other teachers, and drive their professional development. Principals and teachers use the analysis to adjust schedules, deploy resources, and provide support to teachers.

Reporting and Analytics

Reporting and Analytics support the competency-based model by tracking student progress toward mastery and providing other indicators to inform teachers of individual or group progress.

Learning Resource Management

This functional capability relates to the idea of tracking which resources get used and, when tied to assessment data, which resources are effective. This requires heavy reliance on assessment and curriculum data, but it is a powerful tool to enable data-driven instruction.

The technologies that enable these core functional capabilities will need to share data with one another and with the transactional database. Therefore, it is essential that these information technologies be able to “talk” using the same data standards. This requires that the systems be standards-based and follow interoperability design principles. See Section V for more on this topic.

iv. Current Practice and Information Systems

There are a variety of technology-based systems being used by organizations that are implementing competency-based education. Some are as basic as electronic grade book systems, in which teachers manually enter rubric-based scores for the standards or competency. Others include functionality, such as manual and computer-based progress reporting on the learning tasks associated with a competency, and the ability to link the competency to content and assessment resources for a whole class, group of students, or individual student. Still others enable the development and use of competency-aligned resources that use teacher implemented conditional releases and/or intelligent algorithms to build individual learning paths. There is a wide range of functionality in the systems and the reporting capabilities of the systems currently in use, and development efforts in this area are moving rapidly. The number of products in this field is growing and to discuss each of them is beyond the scope of this paper; therefore, the products that are mentioned are discussed within the context of the interviews with the individual institutions that are using them for competency education. However, the inclusion of a product here is not to be considered an endorsement of that product.

A. Inclusion and Use of Content Standards

Since competency education is based on mastery of competencies aligned to standards, the inclusion of content standards is an essential component to the information systems used by the school, district, and state personnel interviewed for this paper. All of the information systems used by these schools support the inclusion of academic content standards. Some of these systems require a manual setup of the standards which requires typing them into the system, while other information systems are able to import the standards as taxonomies from the Achievement Standards Network (ASN) or other providers, using machine-readable representations of the standards. Many of the systems support the inclusion of custom taxonomies and provide a formatted sample file so organizations can import their own taxonomies.

Increasingly, the schools, school systems, and states that are using competency education are using the Common Core State Standards, as well as additional state standards, as the way to track and report on progress and to align resources and tasks. A competency education information system must have the ability to a) tie specific learning objectives, standards, and competencies to discrete learning resources and assessments, b) ensure the alignment of the standards, c) track progress on assessments to the objective level, and d) support a user-friendly dashboard or interface. The information system should allow the integration of content standards into the system using import capabilities and make these available for teachers to assign to resources and assessments.

A well-designed system will result in reducing the administrative burden and workload of teachers by supporting the seamless integration of learning objectives/standards/competencies, assessments, digital content resources, and competency progress reporting, which are all tied to the learning objectives/standards/competencies.

The readily available data, assessments, and content will personalize instruction and enable teachers to focus on working with students. Some IT systems make it very easy for the teachers to assign aligned content and resources—as easy as dragging and dropping a new set of resources into a student’s personalized learning map and having a ready set of activities for the current and next lessons. Drag-and-drop and/or check box systems that support alignment activities are used in BrainHoney and Buzz, Desire2Learn, Diploma.net, Educate, Moodle, etc.

B. Tracking and Reporting of Student Progress

The tracking and reporting of individual student progress on competencies is multilayered and potentially complex. Part of the complexity depends upon how an institution organizes the instructional program and reports on competency mastery.

A competency may be assigned to more than one course; however, most often the progress on that competency is reported within the context of each course and not rolled up into a single competency progress indicator across courses. Some schools, especially elementary schools, organize the competencies by content strands. If a competency is assigned to more than one strand, the progress on that competency would be reported within the context of each strand and not rolled up into a single competency progress indicator across strands. This trend may be partially due to the current limitations of some of the information systems used to support these programs and/or the challenges of interdisciplinary planning.

In most cases today, within either the course-based or strand-based competency mastery tracking context, either a customized grade book program or a competency tracking by strand recording and reporting system is being used. The performance data for the learning tasks can be entered manually by the teacher and/or automatically by an associated instructional/assessment management system. This data might be in the form of a percentage correct, letter grade, “Meets/Doesn’t Yet Meet” option, numeric score, or text description based on a rubric. How this data is compiled for reporting on competency progress varies.

At a minimum, all of the IT systems that are used to support competency education performance tracking have the capability to track student performance against competency-based assessment tasks and display this progress to students and teachers within the context of a course or content strand approach. The assessment tasks are normally assigned at the learning objective level that is either linked to a competency or an essential indicator linked to a competency. Sometimes a single assessment task is associated with the learning objective, but frequently there are multiple tasks and strategies for assessing the learning objective.

Competency Tracking and Reporting

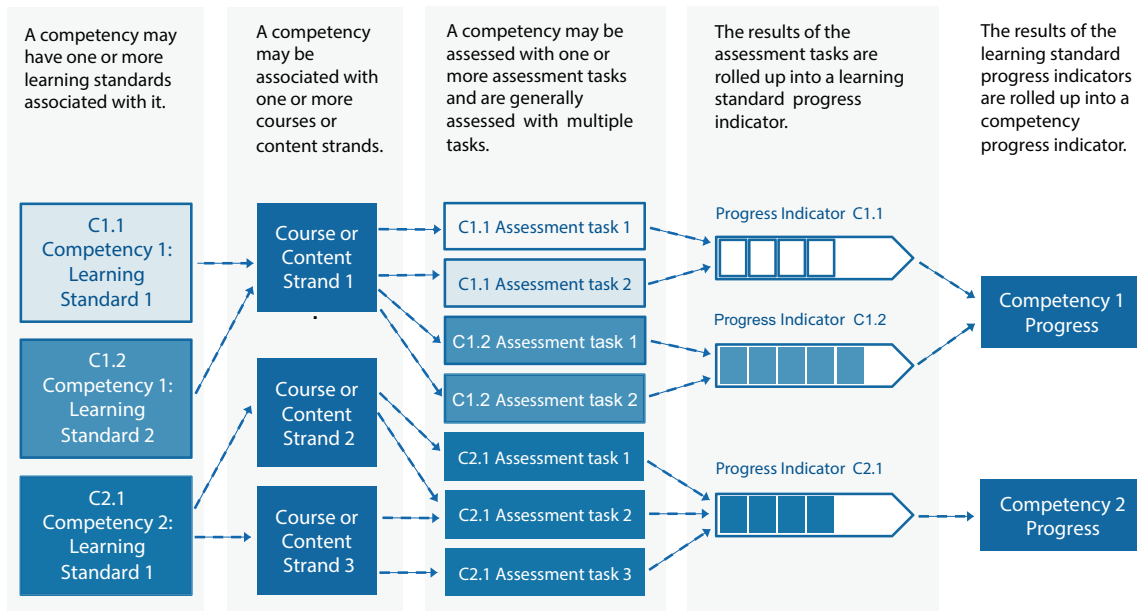


Figure 4. Tracking and Reporting of Student Progress

Some schools are customizing grade book programs such as PowerSchool or GlobalScholar’s Pinnacle product. At Timber Ridge School in Oregon, the staff is using the grade book component of Pinnacle to record and communicate competency progress on the state standards to students and parents. A 4-point scale is used, from “E” = 4 (Exceeds Grade Level Academic Standards) to “N” = 1 (Not Meeting Grade Level Academic Standards). Teachers also include information about missing assignments and assignments that need to be redone and resubmitted.

Principal Jason Hoffert-Hay explained that the focus on reporting progress by mastery of academic standards has allowed the conversation with parents to move from “What’s my child’s grade?” to “What does my child know and still need to learn?”

Sanborn Regional School District (SAU #17) in New Hampshire is using the Pinnacle Suite that includes the grade book, a curriculum and assessment system, and an analytics tool. At Sanborn, each course has anywhere from three to six competencies that are specific to each course. Progress on these competencies, as well as traditional grades, is reported in the grade book. At Sanborn, there are three grade types: Assignment, Competency, and Overall. Assignment grades are based on single assessments and count as 10 percent of the final grade. Competency grades are based on demonstrating mastery on that competency within that course and count as 90 percent of the final grade. Both assignment and competency grades are included in the overall grade calculation for the course.

Other schools use systems designed specifically to support competency education that are standard-centric in the reporting. Adams County School District 50 in Colorado and the Lindsay Unified School District in California use Educate, which employs an electronic grading and reporting system based on the Marzano Taxonomy. It has a 4-point scale that uses a rubric with text descriptions of the progress. These rubric ratings are entered into the system, and a progress indicator for the competency is computed and displayed. In the system, learning targets are aligned to standards, and assessment activities are aligned to the learning targets. This can be done within a single course structure or content strand or across courses or content strands. Every teacher can see the complete body of evidence for every student in every content strand in the data reports if they select that filter. Each teacher can see an individual student's profile of proficiency. Students and parents can sign in and select the Learning GPS to see, by content strand, what has been learned, what is currently being studied, and what will be covered in the future.

The New Hampshire Virtual Learning Academy Charter School is using a customized version of the Genius SIS in combination with a customized version of Moodle to support competency education. Grades are reported according to competencies within a course structure. Students can see progress on competencies and standards. DiplomaPlus.net is used at Diploma Plus school sites across the United States. At the Einstein Education Center in Woodland, California, competency assessment tasks, aligned with the Diploma Plus and state standards, are scored using a 5-point rubric. The scores are included on the report card in two ways, by using either the mean for competencies graded three or four times or the trend line for competencies graded five times or more.

In addition to competency progress reports, some systems are using systems to report on learning trends and others on productivity. For example, Diploma Plus, Pinnacle, and Educate report on learning trends using Marzano's power law. Each system displays a learning trend graph and shows student performance on each of the assessment tasks associated with a learning objective or competency.

Buzz by Agilix labs, used by schools in Michigan's Education Achievement Authority, includes productivity and competency progression reporting. Student progression is a measurement of mastery of the learning standards within a content strand. There are four major content strands representing the four major subjects (mathematics, language arts, science, and social studies) with 18 levels of competency within each content strand. Student productivity is based on successful completion of four learning tasks within the units of learning within each content strand. The student receives a .25 score for each of the learning tasks: Learn, Practice, Apply, Assess. Progress on these tasks is contextualized within pacing expectations set for a unit. This results in a productivity score. Buzz also includes reporting on the students' daily self-assessment of their understanding, interest, and effort. Thus, when teachers look at a whole class report by strand, they can see the progress indicator, productivity indicator, and student daily self-assessment for each student, and then use this information for planning.

Some systems, such as Pinnacle, Desire2Learn, and DiplomaPlus.net, can report on both grades and competency progress. Desire2Learn reports on both grades and progress on competency achievement. Reports on competency achievement include data on the assessment tasks and rubrics associated with the learning objectives that are aligned to the competency. This data is rolled up into a sub-competency or competency attained or not attained indicator. Pinnacle can report on grades, and competency progress can be reported for each assessment task by displaying a grade for the assessment tasks and scores for the standard in the standard grade book view and through a reporting view that shows summarized and detailed progress on standards. DiplomaPlus.net can report on individual competency progress on assessment tasks and an overall final grade for a course.

Florida Virtual School is interested in being able to personalize education by using competency achievement as the way to approach student progression toward graduation, rather than course completion and Carnegie unit attainment. They realize that this would be a major change since competencies are likely to be embedded in several courses rather than just one course. It would also require getting school systems, clients, and the state to accept such an approach. Currently, FLVS is building toward being able to track student progress on competencies and to add standards to courses at the lesson level so they can do course standards alignment and competency mapping.

Rose Colby, a Competency-Based Learning and Assessment Specialist assisting high schools throughout the state of New Hampshire in designing high-quality competency, assessment, and grading reform systems, advises schools to consider having information in the reporting systems to help students really know how they are progressing. She likens it to wanting to lose weight but only have a scale with 10-pound increments. She and other innovators also recognize the need to have systems that can record competency progress and traditional grades for the purposes of transcripts as the field evolves. Schools need to be able to produce both traditional and competency-based transcripts for colleges and the receiving schools of transfer students.

C. Reporting and Analytics

Most systems support student and teacher views of reporting on individual student progress of competency mastery. A personalized learning map shows indicators of green, yellow, or red in some systems—down to the individual competencies. The students can view both a summary and the individual status of their performance. By providing a summary view and then supporting a drill-down view of their performance on individual tasks organized by competency within a course or content strand, students know exactly where they are, whether they are on pace for progress, and what they need help with to advance to the next competency. Ideally, systems would support parent views of this progress as well.

How this data is rolled up and aggregated into reports varies. Many of the existing systems only report progress within a course structure. In a few systems, data is analyzed across the whole institution (beyond individual courses) so that if a competency statement is included in more than one course or content strand, progress on it can be reported using data from any performance measure, independent of where that performance measure is completed.

COMPETENCY EDUCATION, DATA, AND INFORMATION TECHNOLOGY

Several schools have adapted data management products like PowerSchool or Infinite Campus to support performance tracking, but this experience has often been frustrating. These tools lack key features they want, like support for self-paced learning, the ability to track proficiency development across courses and years, and appropriate levels of access for different types of users such as students, staff, and parents.

– *Making Mastery Work: A Close-Up View of Competency*⁴

Where the systems differ considerably is the reporting functions available for school and district leaders. All have proficiency measures at the standard level for each student, but not all have school-level or district-level reports. Most systems have added or are in the process of adding intelligent analytics functions and portals to support this level of reporting.

Having dashboards for school leadership that provide snapshot reports that aggregate student performance by course or content strand is important. Leaders need to see progress for all courses in one screen and also to be able to drill down into courses for detailed reports. For example, a school leader could see that in Mr. Jones's class one-third of the students have passed a competency, one-third have not passed the measures associated with that competency, and one-third have not attempted the measures. Meanwhile, in Ms. Lee's class, one-half of the students have passed the competency, one-third have not passed the measures associated with that competency, and one-sixth have not attempted the measures. The way a principal follows up with each of these teachers could vary based on this data. Those systems that do support this type of analysis also support being able to drill down into these subgroups to determine who the students are and their associated performance on the individual tasks. Pinnacle, Desire2Learn, Buzz, Diploma Plus, and Educate have the reporting capabilities for this type of analysis.

Another lens through which to review competency progress is by longitudinal progress toward competency mastery or across classes. This view is available for individual student mastery in most of the systems, with the exception being some of the pure grade book systems which close out the data at the end of the school year. Since some competencies are multi-year in nature and have sub-competencies that are assessed to determine progress toward competency attainment, the need for reporting systems that can report progress on sub-competencies in relation to a standard or allow for and report reassessments of competencies over a multi-year period is essential.

Being able to see student mastery on a competency by class longitudinally would allow school leaders to see if progression is consistent for class groups and if not, to analyze what differs from one year to the next or one group to the next. With far more robust and complete data than current student data systems are collecting for teacher evaluation, this would be especially useful for looking at school improvement and for organizations that tie teacher evaluation to student performance. Enabling teachers to easily see if competency progression is consistent for class groups and if not, to analyze what differs from one year to the next or one group to the next would empower their teaching.

D. Search and Retrieve Content Resources Aligned with Taxonomy of Standards

Accessing greater content resources aligned to competencies is an important function that many IT systems lack. The ability to integrate content with other student data and learning management systems increases the number and variety of resources available for students and teachers.

Some systems have the capability for teachers to search for resources and tasks by standard, as well as by other metadata. They can then assign these resources and tasks to individuals and groups of students based on the

reports of student progress. In some systems, the teacher can use the conditional release feature of the system to make content resources available based on variables such as individual characteristics, learning performance within the system, and group membership. In addition, some systems support student search and retrieval of resources. Local policies govern whether this permission is given to students. Often these resources are included in content management or repository systems that are part of the system itself. Educate, Diploma Plus, and Pinnacle are systems that host resources within the system but do not integrate with external Learning Object Repository systems. Sometimes these systems are able to integrate with other content vendors, content management, or repository systems through standard-based approaches, such as federating through OAI-PMH⁵ or LTI⁶ integrations, or through custom integrations. Buzz, Desire2Learn, and Moodle are systems that host resources within the system and can also integrate with external systems. To date, no system has integrated with the Learning Registry, but several have included this as part of their roadmaps.

E. Communities of Learning

Supporting the educators, students, and families who take advantage of the data in the IT systems is an essential function. Each of the systems supports electronic communication through discussion forums, and some support email with the ability to control the user permissions by role. Schools use the forums for sharing ideas, problem solving, and providing peer-to-peer support. The schools in the Michigan's Education Achievement Authority project encourage student-to-student support, and Buzz is designed to support this.

F. Integration with Other Data Systems

Building to interoperability standards allows different information systems to integrate with one another without having to customize the systems to enable the exchange of data. Diploma Plus has not been designed using SIF (Schools Interoperability Framework) or IMS standards and does not generally have open APIs. Companies that are not designed to interoperability standards will require more effort to integrate with other systems. The major systems that support competency education in a variety of ways—such as Blackboard, BrainHoney/Buzz, Canvas, Desire2Learn, Educate, Moodle, and Sakai—are built to standards and more easily integrate with other core systems, such as student information systems. However, as new standards and initiatives have been developed and adopted, such as CEDS, AIF, LMRI metadata, inBloom Inc. , and integration with Learning Registry, even these companies are working to include these new developments in their roadmaps. Since they are standards-based and use open APIs—and many of these new developments are extensions or build upon existing standards and use APIs—they are better positioned for rapid development than companies that have not been developed using interoperability standards.

G. Single Sign-On Entry Point for Users

Competency education systems bring together resources from a variety of different systems. Having students, teachers, school leaders, and parents sign into multiple systems to access these resources has been a complaint at a number of the institutions interviewed. Using a single sign-on approach, in which a user signs in once and can then access all of the related information systems, is an important capability for competency education systems.

v. Continuing Development and Evolution of Systems

Development in information systems and technologies to support personalized and competency education is moving forward, and the possibilities are exciting. This section focuses on three powerful developments. First, there are multiple efforts to enhance standards and interoperability of information systems. Second, there is progress in establishing information technology standards for competencies. Finally, advances in learning progressions, intelligent algorithms, and adaptive learning are expanding resources to better serve students.

A. Standards and Interoperability

There are major challenges with the integration and interoperability of IT systems within K–12 education. Fortunately, there are several national initiatives that target information technologies and technical standards to support schools, districts, and states in improving student achievement, narrowing achievement gaps, and increasing high school graduation and college enrollment rates. These initiatives include:

- ***The Common Core State Standards and related work, seeking to add granularity to the learning objectives and make the standards available in machine as well as human readable language***
- ***The Common Education Data Standards (CEDS)***
- ***inBloom Inc., (formerly the Shared Learning Collaborative)***
- ***The Learning Resource Metadata Initiative (LRMI) and Schema.org metadata schemas***
- ***The Learning Registry***
- ***The Assessment Interoperability Framework (AIF) and the assessment consortiums, Smarter Balanced Assessment Consortium and Partnership for Assessment of Readiness for College and Careers (PARCC).***

The work of these initiatives directly supports the development of competency education by contributing knowledge and interoperability, as well as data standards and technical services.

Adapted with permission and input from Jim Goodell's presentation, "Leveraging 'Big Data' to Support Digital Age Learning" at the October 15, 2012, SETDA Leadership Summit.

Multiple Initiatives Working Together

	LRMI/ Schema.org	Learning Registry	inBloom Inc. (formerly the Shared Learning Collaborative)	Assessment Interoperability Framework
Purpose	Metadata for Search Engines; Discovery	Access and share resources nationwide through learning resource data exchange	Shared technical services for personalized learning	Assessment Data Interoperability
Approach	Web crawling	Open source technical system; peer replication	Open platforms	Data transport
Encoding	HTML	JSON, XML	API calls, DIF, IMS, XML	XML
URL	http://www.lrmi.net	http://www.learningregistry.org	https://inbloom.org/	https://ceds.ed.gov/Default.aspx

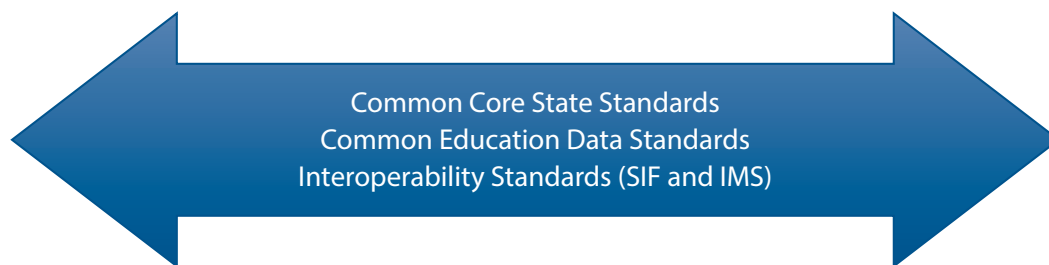


Figure 5. Multiple Initiatives Working Together

A high-level view of these initiatives will be presented in the text of this paper. For a more detailed view, please see Appendix A.

To achieve better results from education information systems, "the need for a complete 'picture' of the learner is critical to link the appropriate resources, programs and content to allow for a successful personalized learning progression."⁷ In order to have a complete picture of a student, there is a need for a standardized approach to the naming and tagging of the data associated with the student—the resources and content, the assessment items, and the progress indicators—if the data, resources, or reports are to be shared beyond a single classroom or school. Consistent, standardized vocabulary describing the learning standards, data elements and entities, and interoperability standards is essential for competency education to scale. There is also the need to have standardized data exchange standards so that software from different institutions and companies can share information.

SHARING WITHOUT BORDERS: THE LEARNING REGISTRY AND THE COMMON CORE STATE STANDARDS

As many states adopt the Common Core State Standards for English language arts and mathematics, the potential for sharing across state borders will expand dramatically.

Consider this: If 20 states each aligned just 50 digital resources to standards from the Common Core and shared that information with other states through the Learning Registry, teachers in every state would have access to 1,000 standards-aligned resources, and they could access these resources via the system they already use.

— *Building a Network of Resource-Sharing States: An Overview of the Learning Registry for State Decision Makers and Strategists*⁸

The Common Core State Standards, the emerging Next Generation Science Standards, individual state standards initiatives, the Granular Identifiers and Metadata for the Common Core State Standards collaborative project, the SIF Association, IMS Global, and the Common Education Data Standards project are all focused on developing consistency in the learning standards vocabulary and data exchange standards. Having a common data vocabulary and data exchange standards will enhance the ability to share data across different information systems. Since competency-based education is likely to pull from multiple systems, this is a significant step forward and is currently impacting, or will impact, vendor development efforts.

As many states adopt the Common Core State Standards for English language arts and mathematics, the potential for sharing across state borders will expand dramatically.

Increasing the ability of teachers and students to search for and retrieve resources aligned to content standards in order to enhance instruction is supported by the Learning Resources Metadata Initiative (LRMI) and the Learning Registry. The LRMI has created a standard markup language for identifying educational content on the Web. The LRMI is being adopted or is under consideration for adoption by states, school systems, publishers, and companies that provide content management services and products, including learning object repertoires and the Learning Registry. Having a consistent and uniform way of tagging content, whether on the Web or in a content management system, will result in more relevant search results and better alignment of resource options to competencies based on standards alignment.

The Learning Registry provides a structured index of metadata—not a repository—of digital educational content. States, school systems, and a variety of government, OER, and commercial sources can contribute metadata about resources to be indexed in the Learning Registry. In addition to sharing data about content alignment, the Learning Registry enables sharing data about the usage of a resource and ratings of resources on such factors as usability and student engagement. After a user completes a search, the search results are presented as a list or icon view of available content directly in a browser or from within other information systems. This makes it easier for teachers and students to find, through one search engine, related content and lesson plans by subject, grade level, or other criteria that is directly aligned with standards.

The contribution of the LRMI and the Learning Registry to competency education could be a significant increase in the aligned resources available to teachers and students. An additional benefit is the user-rating system that would involve the inclusion of data on usage and ratings of the resource by peers.

Another initiative that has the potential to dramatically support highly personalized, competency education environments is inBloom Inc. (formerly the Shared Learning Collaborative). inBloom “is dedicated to bringing together the data, content and tools educators need to make personalized learning a reality for every student.”⁹ inBloom is implementing an open source, shared technology infrastructure that supports the implementation of the Common Core State Standards, helps states and districts provide teachers with the instructional data about their students, and links this data to high-quality and diverse sets of curricular resources.

The SLC adopted the Ed-Fi data specification, which incorporated CEDS 2.0. Subsequently, the inBloom Data Store is based on the Ed-Fi Core XML Schema.¹⁰ The data team has been working with the SIF Association to ensure interoperability with the Schools Interoperability Framework (SIF). This interoperability is facilitated by the use of CEDS to which both Ed-Fi and SIF are aligned.

The work of the inBloom initiative could support competency-based education by providing much of the infrastructure and technical standards needed for exchange and usability of student data and linking of Common Core State Standards to resources, learning map technologies, and open APIs. Vendors will be able to do more rapid and strategic development, and states and school systems will be able to integrate the different components of competency education systems faster and with less custom development of the technology. This enables a greater focus on how the systems can be used to support teaching and learning.

B. Information Technology Standards for Competencies

Exchanging competency performance data between core systems is an area of emerging development. The standards¹¹ for representation of competency data are continuing to be refined in the current CEDS system. The SIF Association Learning Standard Item and Learning Standard Document and IMS Global standard schemas provide constructs for exchanging competency information and are responsive to continual changes in the education landscape around standards. As more work is done to define more granular identifiers for the Common Core State Standards (CCSS) for the Race to the Top Assessment Consortia and further development is achieved around competency frameworks, modifications will need to be made.

There are several efforts involved in work related to the standards for the exchange of competency data. One initiative with the largest potential impact is the [Granular Identifiers and Metadata for the Common Core State Standards](#) (GIM-CCSS) project. This project is defining finer-grained identifiers for the Common Core State Standards. A GIM-CCSS committee is dedicated to defining the data format for these identifiers, which will be nested within the hierarchy of the existing CCSS identifiers. The committee hopes to set a solid precedent with both the format and the data and is coordinating this effort with the Common Education Data Standards (CEDS) project.

In much of the competency education work, the CCSS are embedded within a competency but are not the high-level competency itself. In some instances, they are sub-competencies; in others, they are considered learning objectives or targets. In addition to the CCSS, there are locally developed and other national organization K–12-related skill and knowledge standards. In New Hampshire, the Career and Technical Education (CTE) program uses competencies in conjunction with CTE standards. The competencies span grade levels

and content areas. Information technology standards for exchange of competency data between core systems would need to include scenarios such as this. IMS Global is interested in examining additional use cases beyond Common Core that are targeted United States K–12 scenarios and which may result in evolution of the standards. SIF is refining its standards to be able to report sub-competencies that roll up into competencies and can be reassessed over time. Collaborative efforts in this area would benefit the field.

The technical standards for competencies should include the ability to nest competencies and guidance for modeling of different competency frameworks, such as competency frameworks that consist of a list of competencies with no hierarchical order or other relationships, frameworks that consist of a hierarchical model, and models that include non-hierarchical relationships, dependency, and equivalency relationships. Dependency relationships are particularly useful in STEM fields where one needs to understand one concept before another. Equivalency relationships are used between standards (e.g., *this* Ohio standard is equivalent to *that* Massachusetts standard). The [Achievement Standards Network](#) has schemas for representing these relationships and can store them in their database, which includes standards from all 50 states, the Common Core, The American Association for the Advancement of Science (AAAS), and several others.

Looking at the work done in the medical professions in the United States, Canada, and Europe could possibly help to further development in this area. “With the introduction of Tomorrow’s Doctors in 1993, medical education began the transition from a time-and-process-based system to a competency-based training framework.”¹² In 1996, the Royal College of Physicians and Surgeons of Canada adopted a framework of core competencies for all specialists, called the CanMEDS Roles. A revised version of the CanMEDS framework was adopted in 2005. This framework is the basis for accreditation, evaluation, and examinations in Canada, and has been adopted in many other regions of the world. For example, in the Netherlands, training programs and resource libraries have been built aligned to these competencies.

In 2003, the Institute of Medicine—the health arm of the United States National Academy of Sciences—developed five core competencies for all health professionals. An additional set of four competency domains for interprofessional collaborative practice and the specific competencies within each domain were added in 2011. To facilitate the implementation of these competency frameworks in training, assessments, and resource development and sharing, the MedBiquitous Consortium developed a technical standard for representing competency frameworks in XML. The MedBiquitous Consortium is the American National Standards Institute¹³ accredited developer of information technology standards for healthcare education and quality improvement. The MedBiquitous Competency Framework allows medical schools and other health profession schools to connect their curriculum, learning resources, and assessment data back to this common set of competencies, enabling competency-based views of the curriculum and learner performance. The Framework supports the nested competency model, the competency list, and non-hierarchical relationships between competencies. The Association of American Medical Colleges (AAMC) is building a Curriculum Inventory system that will essentially index medical school curricula across the country. One component of this system will be competency frameworks. Ultimately, the system will allow users to see how specific competencies are being taught and assessed across medical schools, where they are taught in the curriculum, and how much time is devoted to their instruction, etc. The Curriculum Inventory system will use the MedBiquitous standards, including the MedBiquitous Competency Framework, to enable medical schools to electronically transfer their curriculum data to the system. The AAMC’s content portal, MedEdPORTAL, maps resources to the Accreditation Council for Graduate Medical Education (ACGME) competency framework.

As states such as New Hampshire and Maine, districts, and schools continue to move forward in implementing competency education, the need for well-defined standards for exchanging competency performance data between core systems will increase.

C. Learning Progressions, Intelligent Algorithms, and Adaptive Learning

An area of development that would benefit competency education is the use of sophisticated adaptive tutors. “Fundamentally they accept as input the student’s profile and a description of what areas require intervention, and they present to the student online materials, exercises, and so forth. The idea is that the teacher can use a playlist of vetted, appropriate learning resources aligned to state standards and competencies to easily prescribe one or more of these interventions. And, because these interventions may use some of the same or similar items as the summative tests, the teacher can also monitor the results and make before-and-after comparisons.”¹⁴ Some companies that are involved in development in this area include Lockheed Martin with its pilot training, Knewton with its work with Pearson’s MyLab, Octane in designing a K–12-specific system, Aleks, and LiveMocha. Knewton’s current work with Pearson’s MyLab uses APIs to pull data from MyLab into the Knewton platform where Knewton analyzes data about the performance of each student and similar students on the platform, as well as information about the relevance of the educational content. It then recommends the best activity for each student at a particular moment in time, and feeds that recommendation back into MyLab. Knewton hopes to make the Knewton toolkit available for use by anyone, perhaps at minimal or no cost. The capabilities of this type of system, when layered on top of LMSs and online course providers’ systems, would enhance competency-based education. It would support more targeted instruction and more personalized interactions between the students and teachers.

Competencies and the use of intelligent algorithms to support teaching and learning are also on the radar of Advanced Distributed Learning (ADL) Collaborative Laboratories. ADL’s Training and Learning Architecture vision includes experience tracking, learner profiles, competencies, and intelligent content brokering to meet the needs for individualized learning content and systems. The components of their vision are similar to that of an ideal competency-based education environment with the extension of experience tracking through the use of the Experience API. The Experience API, formerly the TinCan API, is one way to capture the data from activities that happen as part of learning experiences.

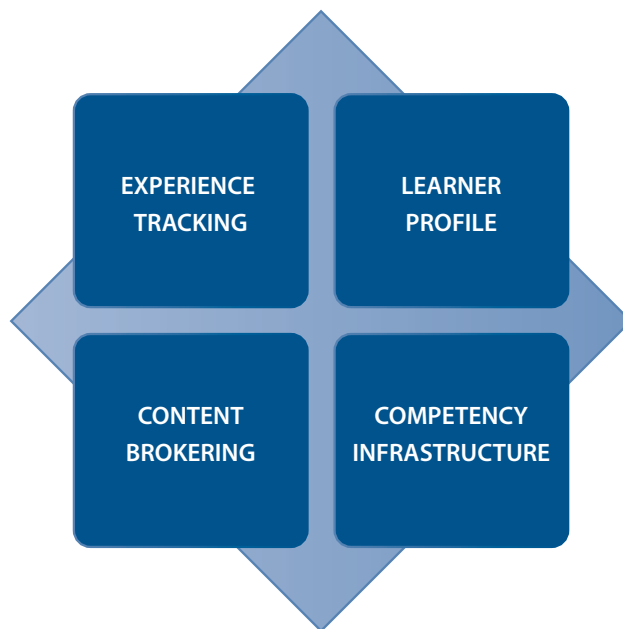


Figure 6. ADL Training and Learning Architecture

People learn and interact with the learning content in many different ways with different devices in different settings. Being able to track and report on learning experiences such as mobile learning, games, social networks and collaborative learning, experiential learning, real life situations, virtual worlds, and simulations is an area of interest to a growing number of developers. Learning itself can also be tracked and reported. The Experience API is being developed by ADL as a way to track both formal and informal learning.¹⁵ It is “a simple, lightweight way for any permitted actor to store and retrieve extensible learning records, learner and learning experience profiles, regardless of the platform used between any type of learning experience and a Learning Record Store¹⁶.”¹⁷ One major advantage of the Experience API is that data from a variety of learning experiences are stored in one place and in one format. The Learning Record Store can send data out to reporting systems, assessment services, statistical services, and analytics.

In the K–12 environment, the ability to pull from multiple devices, across multiple learning experiences and settings in a consistent format, will assist in reporting on and designing learning paths based on user experience and performance.

vi. Conclusion

Over the past three years, competency education has been spreading rapidly throughout the country. Over two-thirds of our states have adopted policies that enable credits to be awarded based on proficiency in a subject. Already two states have made the move to policies for competency-based diplomas. We have spent over a decade developing information systems to support monitoring achievement in a linear, time-based model. It is important that as a country, at the school, district, state, and federal levels, we get ahead of the curve and design—and demand—information systems and products that support competency-based education.

In competency education, each student progresses at a personalized pace with adequate time and support to promote mastery. The information systems that support competency education must be student-centric in their organization of data and interface. “Unless and until system architectures are more directly aligned with the student, the shift in thinking fundamental to the success of Competency Education will not become mainstream”¹⁸ due to implementation barriers.

Although competency education will continue to advance with existing systems, this advancement will be hampered if resources that could be directed toward supporting student learning are directed toward working within multiple systems.

This will be especially true if some systems are focused on student learning and others on compliance, with no effective integration of the systems so that data can inform teachers and students in making progress along learning progressions. Without information systems that are designed to support competency education, the adoption of a competency-based instructional approach will be slower than it would be with well-designed, robust systems.

The real cost of this delay is that many students will have to continue to progress from grade to grade without obtaining the skills and knowledge they need to be on a path to college and career readiness or by obtaining these skills and knowledge at a pace slower than they are capable of. Teachers have the data and resources they need to work with students in intelligent, user-friendly interfaces that take advantage of advanced analytics and adaptive learning capabilities. With the information systems to support competency education, we could ensure that students can advance upon mastery, get the resources, support and access to materials in their own playlists, view their own learning progress on a personalized learning plan, and have access daily to data about what comes next in the course of their studies.

This paper is a step in setting the direction for building the information systems needed for student-centered competency education.

Technology by itself is not the silver bullet, but combined with a solid model for teaching and learning, it becomes an indispensable tool to driving engagement and generating positive outcomes.

– Learning Re-Imagined – Vision for Student Success¹⁹



You can learn more about competency education at [CompetencyWorks.org](https://www.competencyworks.org) as well as links and materials for all the resources mentioned in the paper on the [Competency-Based Pathways wiki](https://www.competencybasedpathways.org).

APPENDIX A: Multiple Initiatives Working on Interoperability, Data Standards, and Technical Services

By having an agreed upon set of competencies, standards, learning objectives, performance tasks, and performance levels, progress on competencies can be assessed and compared across individuals, for individuals longitudinally, across classes, across schools, and, if the competency statements are adopted at the state level, across the state.

Data Consistency in Competency Development and Reporting

To achieve better results from education systems, “the need for a complete ‘picture’ of the learner is critical to link the appropriate resources, programs and content to allow for a successful personalized learning progression.”²⁰ In order to have a complete picture of a student, there is a need for a standardized approach to the naming and tagging of the data associated with the student—the resources and content, the assessment items, and the progress indicators—if the data, resources, or reports are to be shared beyond a single classroom or school. Consistent, standardized vocabulary describing the learning standards, data elements and standards, and the interoperability standards is essential for competency education to scale. There is also the need to have standardized data exchange standards so that software from different institutions and companies can share information.

Consistency in Learning Standards Vocabulary

As Chris Sturgis wrote in *The Art and Science of Designing Competencies*, “Many of the early innovators in competency education developed their practice within schools. As [school systems and] states embrace competency education, state education agencies, districts, and regional education intermediaries are taking on essential roles in supporting the development of competencies.”²¹ One of the emerging roles for schools, districts, and states is supporting the development of competency statements. Often this involves working in collaborative statewide or district-wide groups to define the overarching competency, the associated essential standards and learning objectives, and the performance tasks and performance levels—and then supporting schools with the development of the learning activities and formative assessment tasks as is occurring in New Hampshire.

Critical to this approach is agreement upon a set of learning standards and the naming conventions for these standards. Initiatives that help support this approach are the Common Core State Standards, the emerging Next Generation Science Standards, individual state standards, and the Common Education Data Standards project. In addition, the Granular Identifiers and Metadata for the Common Core State Standards collaborative project by the NGA, CCSSO, SBAC, PARCC, and SETDA will publish an open source set of more fine-grained learning Common Core objectives to refine those standards. Refining the Common Core at a more granular level supports the multi-state assessment consortia, the development of measurable competencies, and the digital alignment of instructional materials and professional development resources. This work will be based on the data models proposed for Common Education Data Standards 3.0 and will be made available through a variety of distribution organizations.

Interoperability in Data Representation and Data Exchange

Although there are some issues with the current state of data elements and data exchange, the Common Education Data Standards (CEDS) project, the Ed-Fi, SIF Association, IMS Global, and inBloom, Inc. (formerly Shared Learning Consortium) are developing an interoperable approach to data definitions and data exchange. The data team has been working with the SIF Association to ensure interoperability with the Schools Interoperability Framework (SIF).

The CEDS supports the use of a consistent, common vocabulary. “The Common Education Data Standards (CEDS) is a specified set of the most commonly used education data elements to support the effective exchange of data within and across states... This common vocabulary will enable more consistent and comparable data to be used throughout all education levels and sectors necessary to support improved student achievement... CEDS is a voluntary effort and will increase data interoperability, portability, and comparability across states, districts, and higher education organizations.”²² The CEDS is a data dictionary and logical data model that leaves serialization and protocol to other standards organizations, such as the SIF association, IMS Global, and Ed-Fi. Many of the CEDS elements are based upon the Assessment Interoperability Framework (AIF) definitions developed by the SIF association and IMS.

In February 2013, SIF will be implementing the SIF Implementation Specification (US) 3.0 release. The SIF Implementation Specification (US) 3.0 will:

- Utilize support tools to map the CEDS 2.0 Logical Data Model to the SIF object schemas, which will control the format of CEDS elements as they appear “on the wire.”
- Enhance the SIF Specification to include an updated, Web-services infrastructure
- Combine the mapping and infrastructure parts of the specification to standardize exactly how SIF applications dynamically exchange and report CEDS 2.0 data
- Standardize the sequence of these CEDS-conformant data exchanges between K–12 applications within a growing set of common educational processes such as Registration, Assessment Scoring, and Student Record Exchange
- Generate and support a certification process, which can verify whether an application is exchanging—as opposed to merely storing—educational data in conformance with the CEDS Logical Data Model

The Ed-Fi Unifying Data Model (UDM) aligns with CEDS and provides “a more structured reference model versus the conceptual model of the CEDS or NEDM standards that provides an ontological organization of education terms. As such the structured UDM may be directly referenced for a variety of data storage, interchange, and visualization and reporting purposes.”²³

CEDS, SIF, and Ed-Fi include a vast array of data elements that are relevant for competency education, such as student progress, assessment, learning standards, content, and content usage descriptors. The standards for competency data elements and data exchange are emerging and are included in the CEDS 3.0 recently released.

Having a common data vocabulary and data exchange standards will enhance the ability to exchange data across different information systems. Since competency-based education is likely to pull from multiple systems, this is a significant step forward, and it is impacting, or will impact, vendor development efforts.

Search and Retrieval of Learning Resources

Increasing the ability of teachers and students to search for and retrieve resources aligned to content standards in order to enhance instruction is supported by the Learning Resources Metadata Initiative (LRMI) and the Learning Registry. The LRMI has created a standard markup language for identifying educational content on the Web; its proposal is currently awaiting official adoption by Schema.org. The LRMI is being adopted or is under consideration for adoption by states, school systems, publishers, and companies that provide content management services and products, including learning object repertoires and the Learning Registry. Having a consistent and uniform way of tagging content, whether on the Web or in a content management system, will result in more relevant search results and better alignment of resource options to competencies based on standards alignment.

The Learning Registry provides a structured index of metadata—not a repository—of digital educational content. States, school systems, and a variety of government, OER, and commercial sources can contribute metadata about resources to be indexed in the Learning Registry. In addition to sharing data about content alignment, the Learning Registry enables sharing data about the usage of a resource and ratings of resources on such factors as usability and student engagement. After a user completes a search, the search results are presented as a list or icon view of available content directly in a browser or from within other information systems. This makes it easier for teachers and students to find, through one search engine, related content and lesson plans by subject, grade level, or other criteria that is directly aligned with standards.

The contribution of the LRMI and the Learning Registry to competency education could be a significant increase in the aligned resources available to teachers and students. An additional benefit is the user-rating system that would involve the inclusion of data on usage and ratings of the resource by peers.

inBloom Inc., (previously the Shared Learning Collaborative)

Another initiative that has the potential to dramatically support highly personalized, competency education environments is inBloom Inc. (formerly the Shared Learning Collaborative). inBloom “is dedicated to bringing together the data, content and tools educators need to make personalized learning a reality for every student.”²⁴ inBloom is implementing an open source, shared technology infrastructure that supports the implementation of the Common Core State Standards, helps states and districts provide teachers with the instructional data about their students, and links this data to high-quality and diverse sets of curricular resources.

The work of the Shared Learning Collaborative (SLC) had been moved forward by the launch of inBloom Inc., a nonprofit provider of the integrated technology services. Developed and piloted by the SLC, “inBloom Inc.,TM data integration and content search services enrich learning applications by connecting them to systems and

information that currently live in a variety of different places and formats while helping to reduce costs for states and districts. This comprehensive view into each student's history can help those involved in education—from teachers to administrators to parents—see students' progress, gain insights into how they might do better and act quickly to help each student succeed. It also helps educators locate standards-aligned instructional resources from multiple providers and match them with their students' needs."²⁵

The inBloom technology includes the following:

- **Data Store:** Secure data management service that allows states and districts to bring together and manage student and school data and connect it to learning tools used in classrooms.
- **APIs:** Provide authorized applications and school data systems with access to the Data Store.
- **Sandbox:** A publicly-available testing version of the inBloom service where developers can test new applications with dummy data.
- **inBloom Index:** Provides valuable data about learning resources and learning objectives to inBloom-compatible applications.
- **Optional Starter Apps:** A handful of apps to get educators, content developers and system administrators started with inBloom, including a basic dashboard and data and content management tools.

inBloom is committed to making its technology open with code for a number of applications already available to developers. inBloom is planning to deliver full source code in the third quarter of 2013."²⁶

The work of this initiative supports competency-based education by providing much of the infrastructure and technical standards needed for exchange and usability of student data and linking of Common Core State Standards to resources, learning map technologies, and open APIs. Vendors are able to do more rapid and strategic development and states and school systems are able to integrate the different components to competency education systems faster and with less custom development of the technology. This enables a greater focus on how the systems can be used to support teaching and learning.

APPENDIX B: Writing an RFI or RFP: Competency Education Information Technology Considerations

Innovators in competency education will likely need to write a request for information (RFI) or request for proposal (RFP) at some point in the program planning and development. It is important for institution, state, district, or school leaders to determine how comprehensive they and their stakeholders want the information solution to be over time. An institution can phase in functionality but should plan for immediate and future desired functionality in an RFI or RFP. As time progresses, these systems may be used by institutions to share individuals' data from the preK–12 school system into elementary, secondary, and higher-education systems and then into the job market. In planning for current and future use, the importance of an open systems architecture framework and data standards, such as CEDS, and interoperability standards is critical. It is unlikely that a single vendor will be able to provide all of the components to the system, so it will be important to keep in mind interoperability and redundancy of systems in the RFP development and review process.

Depending upon the scope of the implementation, an institution might ask RFP responders to address IT system capabilities such as the ones below.

1. Describe your company's current capabilities and strategic direction in reference to competency-based learning. Include:
 - a. Inclusion and Use of Taxonomies
 - Inclusion of taxonomies, such as Common Core, in your product as a core part of your system so that teachers can select the standard and desired learning objectives when building a competency task and aligning content or assessment objects to standards
 - Ability for system administrators to import taxonomies from organizations such as the Achievement Standards Network (ASN) in machine-readable formats including RDF/XML, RDF/JSON, Turtle, or N3
 - Ability for teachers to associate content, quizzes, quiz questions, drop boxes, discussions, grades, and e-portfolio assets with a competency, associated rubric (if any), and competency performance level indicators using the taxonomies within the system and by creating their own
 - b. Resource Development and Management
 - Ability for teachers to create learning content, rubrics, and tasks
 - Ability for teachers or students to search for resources aligned with a learning objective or competency and make the relevant resources available to students
 - Ability for teachers or students to search other content systems and pull in the resources to your product
 - Ability of the system to search for resources aligned with a learning objective or competency and make the relevant resources available to students through an intelligent algorithm based on student performance; determine where this content needs to be to do this search
 - Ability for the system to analyze a course/content offering for competency gaps

c. Reporting and Analytics

- Use of standards for data elements and entities (e.g., CEDS) and data exchange (e.g., IMS and SIF)
- Ability for the system to report on:
 - progress on competencies—individual students over time and in specific or all courses; individual competencies by course (tied to teacher), school, and whole institution over one year and longitudinally
 - materials available to address the standards/objectives; alignment of materials to the competencies; gaps in the materials available to address competencies
 - available materials that are appropriate and most effective for each student and for sets of students with similar characteristics
 - materials that teachers are using, with whom, and in what context
- Reporting and analytics capabilities of your system to support continuous growth models and visualizations, as well as point-in-time reporting

d. Adaptive and Personalized Learning

- System support for learning profiles and personalized learning maps
- Ability of the system to support adaptive learning
- Ability to support personalized learning for teachers based on teacher competency attainment
- System support for the use of student, parent, teacher, and administration dashboards and differentiation of the dashboards by role
- System support for adaptive assessments and online assessments such as those from SBAC and PARCC and other assessment types
- Ability for students to collect items that demonstrate growth toward mastery of a competency and tag them with the associated learning objectives/competency

e. Inclusion of the work of the inBloom services in your product development strategy

2. Describe your company's current capabilities and strategic direction to integrate with other systems, including:

- Use of interoperability standards, such as IMS and SIF, in product development
- Student Information Systems
- Accountability Systems with standards-based assessment information
- Content Management Systems/Learning Object Repositories
- Curriculum mapping systems

- Assessment systems that include Adaptive Assessments, online assessments such as those from SBAC and PARCC, and other assessment types
- Project-based learning platforms/tools
- e-portfolio systems
- Learning Management and Adaptive Learning Platforms
- Analytics systems that support continuous growth models and visualizations, as well as point-in-time reporting
- inBloom services

In the Smarter Balanced System Architecture and Technology Report, the authors recommended system architecture principles to be used during the design process, as guidelines for deciding between options.²⁷ Many of these principles also apply to competency education and should be considered in developing RFIs and RFPs and choosing or developing information systems for competency education. In particular, given the current state of development of competency-based education systems, these three recommendations are especially relevant in considering what to purchase and/or build.

2.1 Choose single-responsibility systems

Similar to the Single Responsibility principle class, this system-level design principle encourages creating or acquiring systems that interact with other systems through standard protocols.

2.2 Design for emergent reuse

Emergent reuse is the ability to identify existing systems that can be used in implementing new systems. Utilizing existing systems in a new application is more effective than designing a new application.

2.3 Develop Homogeneous systems

Developing homogeneous systems is a prerequisite to emergent reuse. Systems that exchange information through common standard protocols are easier to manage and enhance.²⁸

APPENDIX C: Glossary

Advanced Distributed Learning (ADL) <http://www.adlnet.org/>

The ADL Initiative was established in 1997 to standardize and modernize training and education management and delivery, and is part of the Department of Defense Office of the Deputy Assistant Secretary of Defense (Readiness). The vision of the ADL Initiative is to provide access to the highest quality learning and performance aiding that can be tailored to individual needs, and delivered cost effectively at the right time and at the right place.

Assessment Interoperability Framework (AIF) <https://ceds.ed.gov/aif.aspx>

The SIF Association and the IMS Global Learning Consortium have just released version 1 of the AIF as part of a joint partnership established to support the U.S. Department of Education's Race to the Top Assessment (RTTA) Consortia. This unprecedented collaboration between the two leading educational data standards offers a significant advance over paper assessments, which are now demonstrably inferior to their electronic counterparts with respect to cost, processing time, and ability to personalize instruction and leverage centralized professional development resources.

Common Education Data Standards (CEDS) <https://ceds.ed.gov/>

The CEDS project is a national collaborative effort to develop voluntary, common data standards for a key set of education data elements to streamline the exchange and comparison of data across institutions and sectors.

Federated search

Federated search is an information retrieval technology that allows the simultaneous search of multiple searchable resources. A user makes a single query request that is distributed to the search engines participating in the federation. The federated search then aggregates the results that are received from the search engines for presentation to the user. (Wikipedia http://en.wikipedia.org/wiki/Federated_search)

IMS specifications and standards

IMS specifications and standards cover most of the data elements used in "distributed and collaborative learning." IMS specifications promote the adoption of learning and educational technology and allow selection of best-of-breed products that can be easily integrated with other such products. These include a wide variety of technologies that support or enhance the learning experience, such as Web-based course management systems, learning management systems, virtual learning environments, instructional management systems, student administrative systems, e-portfolios, assessment systems, adaptive tutoring systems, collaborative learning tools, Web 2.0 social learning tools, learning object repositories, and so forth. These include technologies and products that support learning situations that involve support for collaborative learning involving learners and instructors. The learners may be in a traditional educational environment (e.g., a [school classroom](#) in a [university](#)), in a [corporate](#) or [government training](#) setting, or at [home](#). (Wikipedia http://en.wikipedia.org/wiki/IMS_Global)

Interoperability

Interoperability is a property of a product or system, whose interfaces are completely understood, to work with other products or systems, present or future, without any restricted access or implementation. (Wikipedia <http://en.wikipedia.org/wiki/Interoperability>)

Interoperable

Of or relating to the ability to share data between different computer systems, especially on different machines: interoperable network management systems. (World English Dictionary <http://dictionary.reference.com/browse/interoperable?s=t>)

Learning Registry <http://www.learningregistry.org/>

The Learning Registry is a new approach to capturing, sharing, and analyzing learning resource data to broaden the usefulness of digital content to benefit educators and learners. It is an open source technical system designed to facilitate the exchange of data behind the scenes, and an open community of resource creators, publishers, curators, and consumers who are collaborating to broadly share resources, as well as information about how those resources are used by educators in diverse learning environments across the Web.

Learning Resource Metadata Initiative (LRMI) <http://www.lrmi.net/>

The LRMI has developed a **common metadata framework** for describing or “tagging” learning resources on the Web.

Metadata

Metadata describes other data. It provides information about a certain item’s content. For example, an image may include metadata that describes how large the picture is, the color depth, the image resolution, when the image was created, and other data. A text document’s metadata may contain information about how long the document is, who the author is, when the document was written, and a short summary of the document. Web pages often include metadata in the form of [meta tags](#). Description and keywords meta tags are commonly used to describe the Web page’s content. Most search engines use this data when adding pages to their search index.

(Definition: <http://www.techterms.com/definition/metadata>)

Partnership for Assessment of Readiness for College and Careers (PARCC) <http://www.parcconline.org/>

The Partnership for Assessment of Readiness for College and Careers (PARCC) is a consortium of 23 states plus the U.S. Virgin Islands working together to develop a common set of K–12 assessments in English and math anchored in what it takes to be ready for college and careers. These new K–12 assessments will build a pathway to college and career readiness by the end of high school, mark students’ progress toward this goal from 3rd grade up, and provide teachers with timely information to inform instruction and provide student support. The PARCC assessments will be ready for states to administer during the 2014–2015 school year. PARCC received \$186 million in grant funds from the U.S. Department of Education’s [Race to the Top assessment competition](#) to support the development and design of the next-generation assessment system. Collectively, the states in PARCC educate about 25 million students and include 10 of the 12 Race to the Top winners.

inBloom Inc. (formerly Shared Learning Collaborative) <https://www.inBloom.org>

inBloom Inc. is a nonprofit organization established to carry forward the mission of the Shared Learning Collaborative. inBloom provides technology services that allow states and public school districts to better integrate student data and learning applications to support sustainable, cost-effective personalized learning. inBloom is funded with initial philanthropic support from the Bill & Melinda Gates Foundation and Carnegie Corporation of New York. <https://www.inbloom.org/inbloom-launch>

Shared Learning Collaborative (SLC) <http://slcedu.org/>

The SLC worked to make personalized learning a reality for every United States student by improving the usefulness, variety, and affordability of education technology. A non-profit, inBloom, Inc. has been launched to carry-on the work started by the SLC.

SIF (Schools Interoperability Framework) Association <http://www.sifinfo.org/us/index.asp>

The SIF Association is a non-profit membership organization whose members include over 3,200 software vendors, school districts, state departments of education, and other organizations active in primary and secondary (pK–12) markets. These organizations have come together to create a set of rules and definitions which enable software programs from different companies to share information. This set of platform-independent, vendor-neutral rules and definitions is called the SIF Implementation Specification. The SIF Specification makes it possible for programs within a school or district to share data without any additional programming and without requiring each vendor to learn and support the intricacies of other vendors' applications. The goal of the SIF Association is to make it possible for school administrators, teachers, and other school personnel to have access to the most current and accurate data available.

Smarter Balanced Assessment Consortium (SBAC) <http://www.smarterbalanced.org>

Smarter Balanced is a state-led consortium of 25 states developing assessments aligned to the Common Core State Standards in English language arts/literacy and mathematics that are designed to help prepare all students to graduate high school college- and career-ready. The SBAC focus is on assessing students annually in grades three through eight in English language arts and mathematics and once in grades ten through twelve under current federal requirements. Smarter Balanced is one of two multistate consortia awarded funding from the U.S. Department of Education in 2010 to develop an assessment system aligned to the Common Core State Standards (CCSS) by the 2014–2015 school year.

Student-Centered Learning

Student-centered learning (SCL), or learner-centeredness, is a learning model that places the student (learner) in the center of the learning process. In student-centered learning, students are active participants in their learning; they learn at their own pace and use their own strategies; they are more intrinsically than extrinsically motivated; learning is more individualized than standardized. Student-centered learning develops learning-how-to-learn skills such as problem solving, critical thinking, and reflective thinking. Student-centered learning accounts for and adapts to different learning styles of students (National Center for Research on Teacher Learning, 1999) http://www.intime.uni.edu/model/center_of_learning_files/definition.html

Endnotes

¹ *Making Mastery Work: A Close-Up View of Competency Education*. Nora Priest, Antonia Rudenstine, and Ephraim Weisstein. November 2012. <http://www.competencyworks.org/resources/making-mastery-work/>

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