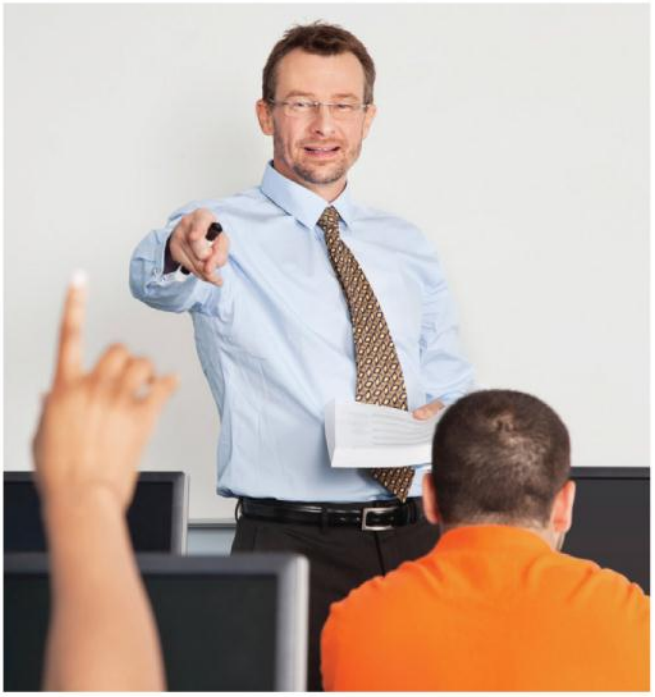
Open Educational Resources and Open Source Technologies: Applicability to Career and Technical Education and Workforce Development Programs



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www.illinoisworknet.com/pathways

ILLINOIS Pathways
Science, Technology, Engineering & Math

The following information is intended to provide background information on the current technologies that are in development largely to support academic education, in particular implementation of the Common Core State Standards, and the potential for expansion to career and technical education (CTE) and workforce development areas.

The examples provided related to CTE and workforce development programs were developed solely for this paper and related presentation material are not endorsed by any state or national organizations.

In addition to this paper, an executive summary, series of brief videos, infographic, and other related information is posted on the Illinois Pathways website.

Visit http://www.illinoisworknet.com/ilpathways to learn more.

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Introduction

This paper is intended to identify examples of open source technologies and Open Educational Resources (OER) that can be extended and adapted to benefit secondary and postsecondary career and technical education (CTE) and workforce development programs, and identify challenges that need to be addressed to fully realize the benefits of them. Expanded access to new open source technologies and OER is creating more opportunities for improving educational programs. There are open source technologies and OER that are not acknowledged in this paper that may also offer opportunities for improving education. It is not the intent of this paper to provide an inventory of them but to identify several of the more prominent national initiatives that can be used across school, district, and state borders.

To understand the issues and advantages presented, the following definitions are used:

Open Source Technologies - Open source refers to a program or software source code that is available to the general public for use and/or modification from its original design free of charge. For example, Microsoft's CodePlex website hosts thousands of open source, free software applications such as content and learning management systems for downloading and customizing.

Open Educational Resources (OER) - OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. OER include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge (Atkins, Brown, & Hammond, 2007).

Career and Technical Education (CTE) - CTE programs are funded in part by the Perkins Act to prepare both youth and adults for a wide range of careers and further educational opportunities at less than the baccalaureate level. These careers may require varying levels of education - including industry-recognized credentials, postsecondary certificates, and two- and four-year degrees.

Workforce Development – Programs, including those funded by the Workforce Investment Act, to prepare adults and youth with employability and technical training, and related employment services.

Preparing a Highly Skilled Workforce

Economic challenges have created an opportunity to change our understanding of education and training programs and create new and innovative approaches to preparing a talent pipeline of highly-skilled workers. In 1973, a high school diploma was viewed as the passport to the "American Dream" as 72% of the workforce had no more than a high school degree. Still today, only 40% of young adults in the U.S have earned an associate's degree or higher. For those without a high school degree or some postsecondary education, job prospects will be limited. A study conducted by Georgetown University, Center on Education and Workforce, predicts more than 418,000 jobs will be created for workers with some college, a certificate, or an Associate's degree between 2008 and 2018 (Carnevale, Smith, & Strohl, 2010). Forecasts are not as promising for workers with only a high school education. Almost 80% of our nation's wages are earned by postsecondary-educated workers. Among others, these forecasts reaffirm the need for postsecondary education and training if the U.S. intends to compete in the global economy.

Although unemployment remains high, the U.S. does not have the skilled workforce that it needs to meet projected job growth. The nation will have to prepare 22 million postsecondary degreed students to meet job demands by 2018. More so, the mismatch between employer needs and job readiness by prospective employees is prominent in Science, Technology, Engineering, and Math (STEM) areas, such as manufacturing and heath care. Some industries have surpluses of skilled workers, whereas others have a much smaller talent pool. While the total number of jobs in the United States will grow by 10% between 2008 and 2018, the number of STEM jobs is projected to grow by 17%, making it one of the most dynamic occupational clusters in the economy (Carnevale, Smith, & Strohl, 2010).

Economic trends show and employers verify that CTE and workforce development programs can play a significant role in improving graduation rates, preparing credentialed workers, updating programs to align academic and technical standards, and developing a highly skilled workforce. National efforts are underway to increase openness, sharing, and use of digital learning resources aligned to learning standards. However, the new infrastructure and open source tools are being created largely for K-12 academic curricula. To benefit students, schools, and employers, these tools need to be adapted for use by CTE and workforce development programs at both the secondary and postsecondary levels.

Illinois Pathways

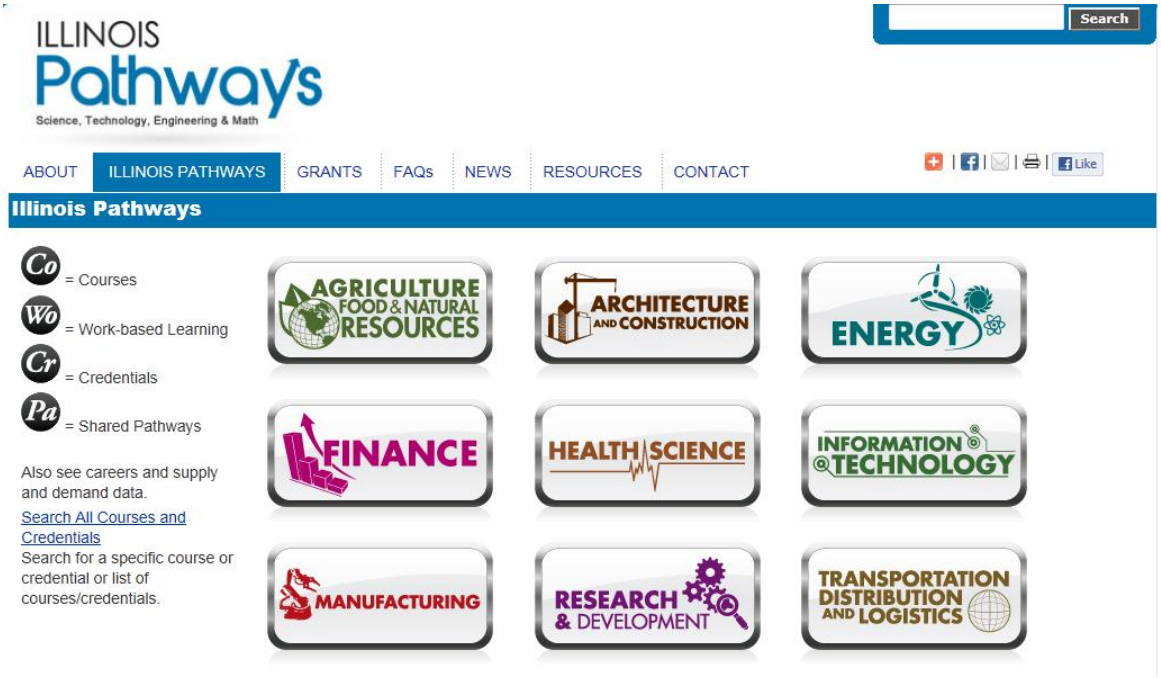
Illinois Pathways, through the U.S. Race to the Top initiative, is a new and innovative Illinois-led STEM education initiative designed to support college and career readiness for all students (Tyszko, 2012). Through a partnership between the Illinois education and economic development agencies, Illinois Pathways supports local programs that empower students to explore their academic and career interests. It is also creating new statewide, public-private partnerships known as Learning Exchanges to better coordinate investments, resources, and planning for those programs.

P-20 STEM Programs of Study are organized around nine career clusters and feature a series of orientation and advanced pathway courses across education institutions. The pathways offer opportunities for students to enrich their learning through work-based learning experiences as well as demonstrate their competence through assessments and industry credentialing. Originally developed and implemented as part of CTE, the nine P-20 STEM Programs of Study serve as a model for bridging programs across P-20 education institutions. The programs have demonstrated the ability to improve academic achievement, increase graduation rates, and improve transitions to postsecondary education and employment. Further, these Programs of Study are designed to improve access and success for underrepresented populations in STEM fields, such as females, minorities, low-income, and disabled students.

To address the critical skills shortage and create a pipeline of highly skilled workers, access to high-quality educational resources in the P-20 educational spectrum is crucial.

Figure 1 illustrates the Illinois Pathways website page to show how the Programs of Study are organized around career clusters. As shown, there are nine Illinois Pathways focused on areas of high industry demand. Aligned to the National Career Cluster Framework, P-20 STEM Programs of Study enable Illinois educational institutions to align their curriculum, assessments, and career counseling with the growing economic development sectors. The goal is to help students make successful transitions to employment and foster a stronger economy for Illinois.

Figure 1 - The Illinois Pathways include the following career clusters: Agriculture, Food and Natural Resources, Architecture and Construction, Energy, Finance, Health Science, Information Technology, Manufacturing, Research and Development, and Transportation, Distribution and Logistics.



Illinois Pathways' STEM Learning Exchanges are new, innovative public-private education partnerships that are organized to support local implementation of P-20 STEM Programs of Study by coordinating statewide networks of education partners, businesses, industry associations, labor organizations, and other organizations. Learning Exchanges are organized by career cluster and work to coordinate planning and investment, aggregate resources, and review talent supply-chain performance.

Learning Exchanges provide a new infrastructure to coordinate investments at a statewide level to better connect and serve local programs in a similar career cluster, and track local and statewide student performance. Each sector-based Learning Exchange is governed by consortia of education, business, and community partners with a specific entity serving as a fiscal agent. Learning Exchanges are required to have a state-approved strategic plan and have a state designation, but they operate as independent, voluntary public-private networks.

The Illinois Pathways Initiative provides a strategy to help achieve the states' P-20 Council's goal of 60% of all Illinois residents attaining a high-quality academic degree or industry recognized certificate or credential by 2025. This includes:

- *Personalization* – Education and career plan aligned to academic and career interests.
- *Applied Learning* – Access to work-based learning opportunities.

- *College & Career Readiness Assessments* – 1) Academic, 2) Career, and 3) Technical.
- *Orientation Courses* – Foundational skills across clusters, called "orientation" at high school and "bridge" for adults.
- *Shared Pathway Courses* – Common pathways skills and reduced switching costs.
- *Early College* – Dual credit in "gateway" courses to improve transfer and reduce costs.
- *Diverse Delivery System* – Build program capacity through academic core, CTE courses, electives, regional centers, virtual courses, and college courses.

To meet the needs of students, educators, and employers, the Illinois Pathways and Illinois Shared Learning Environment (ISLE), also funded by the Race to the Top federal grant and the State of Illinois, is building a technology infrastructure that provides capacity for benefitting all schools statewide. Within the Illinois Pathways framework, teaching and learning experiences can be improved even further by adapting new open source technologies and by using and contributing to Open Educational Resources.

Shared Learning Infrastructure

Colorado, Illinois, Massachusetts, New York, and North Carolina are participating in a Shared Learning Collaborative (SLC) Phase I Pilot Program which started June 2012. Delaware, Georgia, Kentucky, and Louisiana are scheduled to participate in a Phase II Pilot Program followed by an open invitation to other interested school districts and states to adopt the services (Shared Learning Collaborative, 2012). The SLC mission is focused on helping educators personalize student learning, align States Common Core Standards with educational resources, provide access to high-quality and open resources, and use learning analytics to inform and improve the quality of instruction.

Sponsored by Carnegie Corporation of New York and the Bill & Melinda Gates Foundation, the SLC is an alliance of states, districts, educators, foundations, and content and tool providers who are passionate about using technology to improve education. The SLC is building a Shared Learning Infrastructure (SLI) for statewide access to a set of open source applications and tools for academic education. The SLC technology includes a testing environment with a software development kit (SDK) to provide application developers the tools, forums and community support needed to develop innovative content and resources that are compatible with the technology. SLI technology is designed to help states and districts take advantage of purchasing and licensing efficiencies, making a greater wealth of resources available to educators and students.

The SLI is divided into two main layers (SLC Pilot Phase Project Documents, 2012):

- The applications layer includes SLI core applications, State Education Agency (SEA)/Local Education Agency (LEA), and developer or vendor applications. SLI offers a set of applications, like those found in a smart phone, that gives educators access to the information and data that can help them analyze student performance and adjust instructional strategies to improve student outcomes.
- The multitenant data store layer (i.e., shared by multiple schools and districts) hosts a core set of classroom-level education data elements that are commonly used in the K-12 educational information domain. This open source SLC technology will allow states and districts to integrate student data that currently exists in multiple systems so they may better manage data and use it to improve instruction.

The SLC is building off the work of other national open source and OER efforts such as the Learning Registry (LR), Learning Resource Metadata Initiative (LRMI), and Ed-Fi™:

- The LR stores traditional descriptive data and also allows for sharing of ratings, comments, downloads, and standards alignment. This is an open technology framework to which any content creator can publish and any technology developer can leverage for their applications. For example, lesson plans, assessments, videos, and many other OER can be downloaded and aligned to States Common Core Standards.
- LRMI, led by the Association of Educational Publishers and Creative Commons, is defining the parameters by which users search and filter learning resources. For example, users are able to narrow search results according to subject area, grade level, educator resource, and standards alignment.
- The Ed-Fi open educator dashboards and data specifications are being used to integrate student and classroom-level data. For example, educators could see a complete picture of their students' progress to determine where they need additional help and more personalized learning. By agreeing to a free license, states, school districts, nonprofit organizations, and vendors can use the Ed-Fi schema, source code and documentation in projects, services and products.

The SLI applications and tools will have several impacts on schools including:

- Accessing secured, state-of-the-art dashboard tools that integrate local student information systems to provide learning analytics.
- Creating and sharing new applications and tools.
- Developing learning maps based on common core standards that personalize the education experience and give schools, educators, and students timely and relevant guidance.
- Lowering technology access costs.
- Minimizing time to use and share OER and non-OER tagged to standards with usage data and user reviews.

Clearly, the SLI needs to be extended to secondary and postsecondary CTE and workforce development programs. The chart on the next page provides several examples of SLI components that will become available to pilot states between June 16, 2012 and December 12, 2012 (Bates, 2012). This is not a complete list of all components; others may be released as the pilot progresses. The examples below all assume participating schools provide student data to the SLC data store for integration with dashboards and other applications.

SLI Components	What it Does	Example CTE and Workforce Development Use Scenarios
Content Search Application	This application provides for discovery of learning resources based on search, user role, content filters, and other contextual information. The search app queries the LRI, as well as Internet search engines. The search app is provided via the SLC user portal, and may also be used as a standalone website-compatible utility.	Provide an open access search application that allows educators, content creators, publishers, and others to find, tag, align, and evaluate CTE and workforce development resources.
Content Tagging Tool	This interactive tool is used to label resources as to its intended audience, applicability, and alignment to learning standards. The generated resource descriptions are published to the LRI. The utility will be available both as an "app" through the SLC portal and as a standalone website-installable version, optimized for batch-tagging of multiple resources.	Extend the tagging tool to identify CTE and workforce development program subjects and align resources to academic, technical, and employability standards.
Dashboards	Dashboards allow educators to see information about their students individually or by class, school, and other organizational levels. Access is based on role. The educator dashboard provided by the SLC is intended to be an exemplar application utilizing the standard set of application APIs. SLC-provided dashboards are in Open XML format and may be modified, customized, or substituted.	Create teacher and student dashboard views that support peer-to-peer collaboration as well as provide student information and course builders that bring in the full range of credentials and academic, employability, and technical standards to create effective courses.
Learning Map Authoring Tool	The Learning Maps Authoring Tool is used by curriculum teams or solution to provide a select set of Learning Objectives (Common Core State Standards or other State Standards) to create arrangements, or paths, through the objectives.	Identify employability and technical standards to select sets of learning objectives and provide best practices.
Learning Maps Visualization Tool	The Learning Maps Visualization Tool provides a graphical representation and rendering of Learning Map pathways authored by SEA or LEA teams.	Develop learning map visualizations based on career clusters that depict occupational training.
LR Index (LRI)	The LRI stores Learning Objective and Resource metadata to fulfill queries for learning resources quickly and with improved contextual awareness.	Contribute to the LRI by creating, sharing, tagging, evaluating, and aligning CTE and workforce development resources to technical and employability standards.
Portal Application	The Portal home page is a single destination for all SLC-approved applications. It provides a master list of applications available to educators in one convenient location.	Make career development applications available to educators and students.

Of the several SLC components listed, this paper examines the learning map and dashboard components which are dependent upon access to employability and technical standards.

Learning Maps

Learning maps will connect educators and students to relevant States Common Core Standards and other state academic standards content by utilizing the LRMI tagging schema and the LRI. Students' learning progress will be dynamically tracked through the maps (Learning Maps, 2012).

Learning maps are a graphical representation of student learning that will help educators and students visualize student learning progress and needs. The SLI is to provide two initial learning map visualizations, referred to as skins, a treasure hunt map and a pin ball map. A treasure hunt map looks like an old-fashioned pirate's treasure map, showing standards as clues along a route that are needed to attain a goal. A pinball map is reminiscent of a pinball arcade game, showing the pinball hitting targets and responding by moving to the next target.

The operative metaphor for the learning map is Google Maps. The intent is for the visualization tools to allow an educator, for example, to annotate the map with the equivalent of "points of interest" and "travel directions" that highlight specific learning objectives, resources, curriculum elements, and pathways relevant to a lesson plan or a student's individual learning plan. A given curriculum will specify a path through the learning map, and a suite of tools will allow authoring and visualization of the learning map. It provides an organizing framework that maps the relationship between learning objectives, including dependencies and higher level groupings (Learning Resource Metadata Initiative (LRMI) – RFP Guidance, 2012).

Learning standards are the basis for creating learning maps. For example, when creating a lesson, an educator may need to teach Math and English standards. To create a map, the educator selects the relevant math and reading standards. Once the standards are identified, the learning map can also bring in resources that align with the standards. The visualization tool has to be able to identify each standard and know if one must be learned prior to the other and the expected outcome of learning the standards to visually connect them. Therefore, to create learning map visualizations, there are three essential LRMI metadata properties required:

1. *Teaches Competencies* - This is the competency, learning standard, and/or skill that the work teaches.
2. *Requires Competencies* - This is the competency, learning standard, and/or skill that the work requires the user to already have (i.e., prerequisite standard).
3. *Assesses Competencies* - This is the competency, learning standard, and/or skill that the work assesses.

The Learning Map Visualization Tool allows for creating any number of learning maps based on learning standards. This is an opportunity to create learning maps for CTE and workforce development programs. However, to create them, employability and technical learning standards need to be made available for open access and follow LRMI essential

metadata properties to create learning maps and be tagged to OER. This is a challenge that can be addressed by implementing a national strategy and involving industries and organizations who have identified employability and technical standards.

Figure 2 - Sample CNC Learning Map

As an example for this paper, Figure 2 shows a Computer Numerical Control (CNC) learning map. The clusters of hexagons can be used to view an entire course of study. With this example, the map is read from the bottom left moving diagonally upward to the right. Hexagons are placed to show connections and relationships between academic, technical, and employability standards.

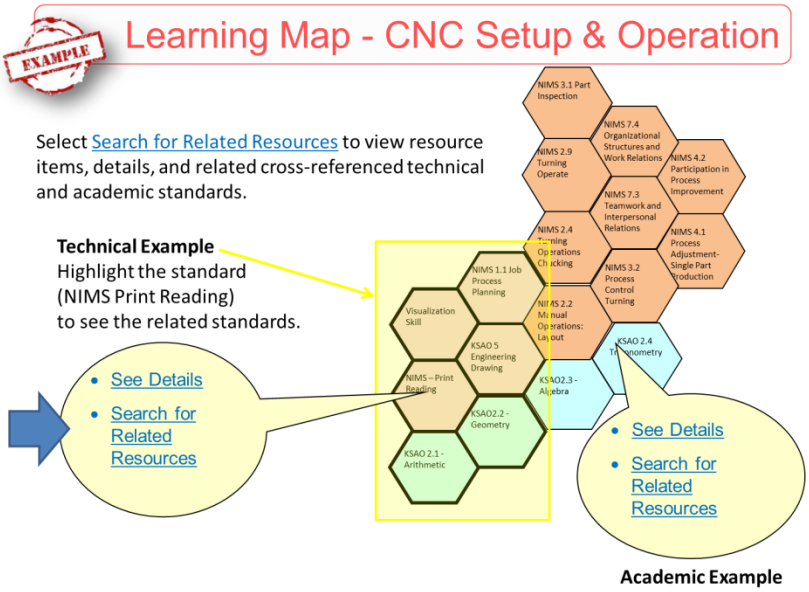


Figure 3 - Example CNC Setup and Operation Learning Map

Figure 3 shows what a CNC Operation and Maintenance learning map might look like using the SLI Learning Map Visualization Tools. This learning map would be created by identifying the academic, employability, and technical standards to be learned, as well as related resources and credentials. With this example, the standards would need to include States Common Core Math, National Institute of Metal Working, and National Manufacturing Career Cluster Standards. The sample learning map uses graphics that relate to learning CNC Operation and Maintenance.

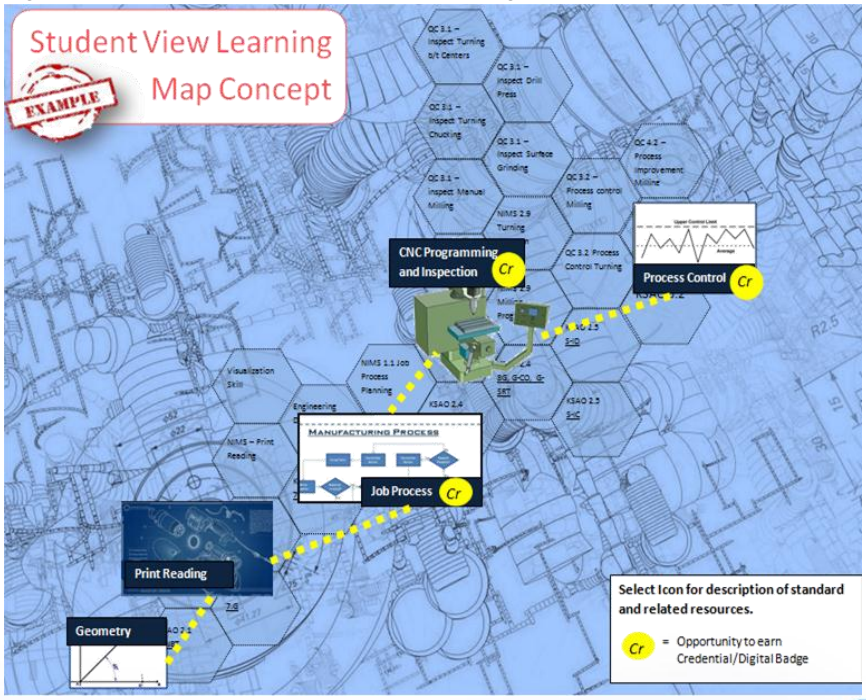
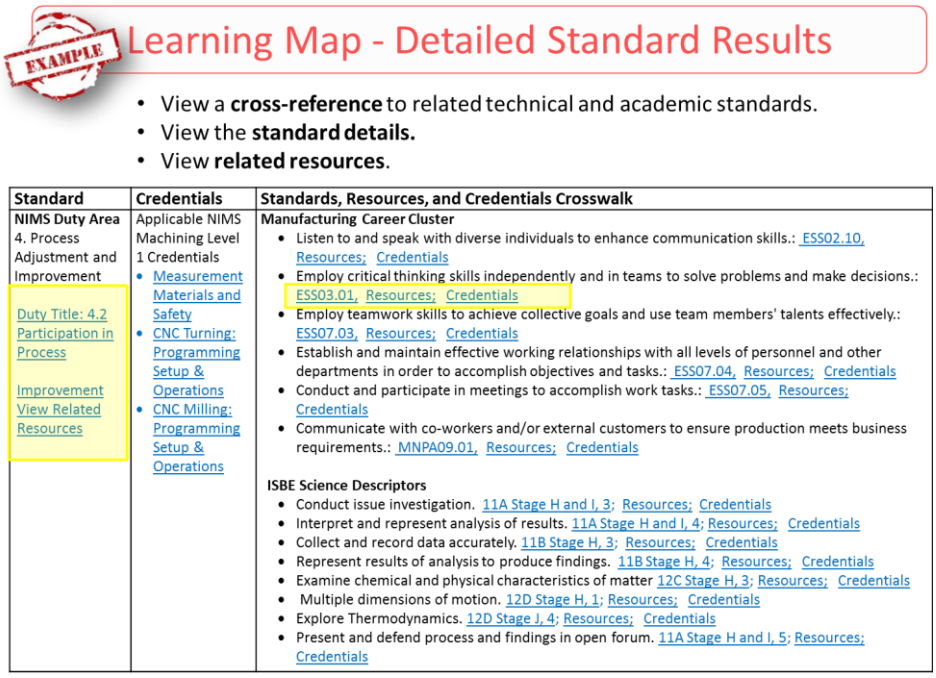


Figure 4 shows an example crosswalk of academic, employability, and technical standards with related resources and credentials for educators that could be viewed by clicking on a graphic in the learning map. In this example, the map shows academic standards for mathematics, National Institute of Metal Working (NIMS) technical standards, and National Career Cluster's Knowledge and Skill Statements for Manufacturing.

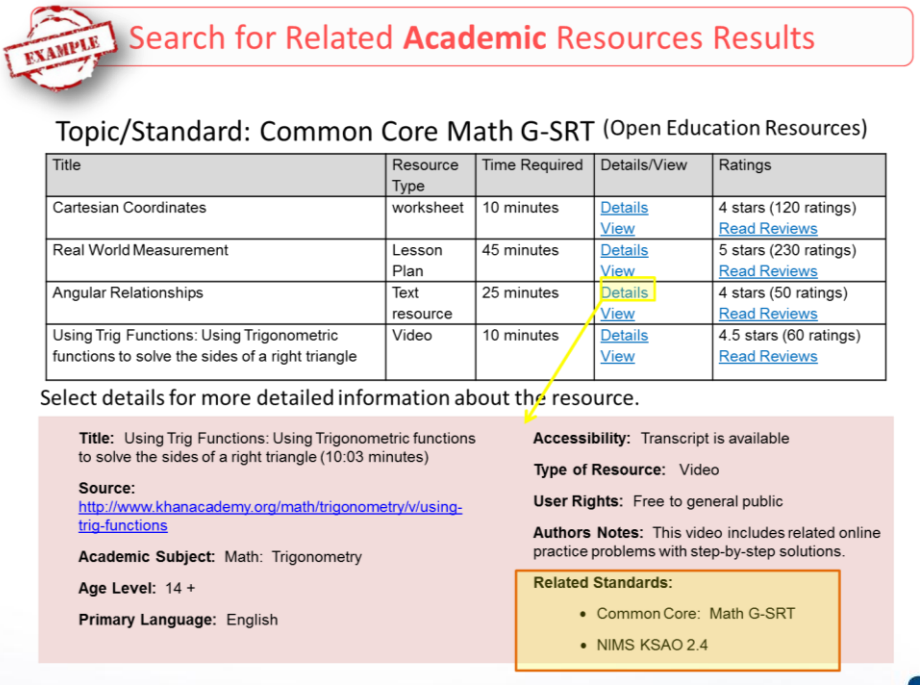
Figure 4 - Sample standards crosswalk linked to the CNC Setup and Operation Learning Map.



Standard	Credentials	Standards, Resources, and Credentials Crosswalk
NIMS Duty Area 4. Process Adjustment and Improvement Duty Title: 4.2 Participation in Process Improvement View Related Resources	Applicable NIMS Machining Level 1 Credentials • Measurement Materials and Safety • CNC Turning: Programming Setup & Operations • CNC Milling: Programming Setup & Operations	**Manufacturing Career Cluster** • Listen to and speak with diverse individuals to enhance communication skills.: ESS02.10, Resources; Credentials • Employ critical thinking skills independently and in teams to solve problems and make decisions.: ESS03.01, Resources; Credentials • Employ teamwork skills to achieve collective goals and use team members' talents effectively.: ESS07.03, Resources; Credentials • Establish and maintain effective working relationships with all levels of personnel and other departments in order to accomplish objectives and tasks.: ESS07.04, Resources; Credentials • Conduct and participate in meetings to accomplish work tasks.: ESS07.05, Resources; Credentials • Communicate with co-workers and/or external customers to ensure production meets business requirements.: MNPA09.01, Resources; Credentials **ISBE Science Descriptors** • Conduct issue investigation. 11A Stage H and I, 3; Resources; Credentials • Interpret and represent analysis of results. 11A Stage H and I, 4; Resources; Credentials • Collect and record data accurately. 11B Stage H, 3; Resources; Credentials • Represent results of analysis to produce findings. 11B Stage H, 4; Resources; Credentials • Examine chemical and physical characteristics of matter 12C Stage H, 3; Resources; Credentials • Multiple dimensions of motion. 12D Stage H, 1; Resources; Credentials • Explore Thermodynamics. 12D Stage J, 4; Resources; Credentials • Present and defend process and findings in open forum. 11A Stage H and I, 5; Resources; Credentials

Figure 5 - Sample of resources displayed based on learning standards.

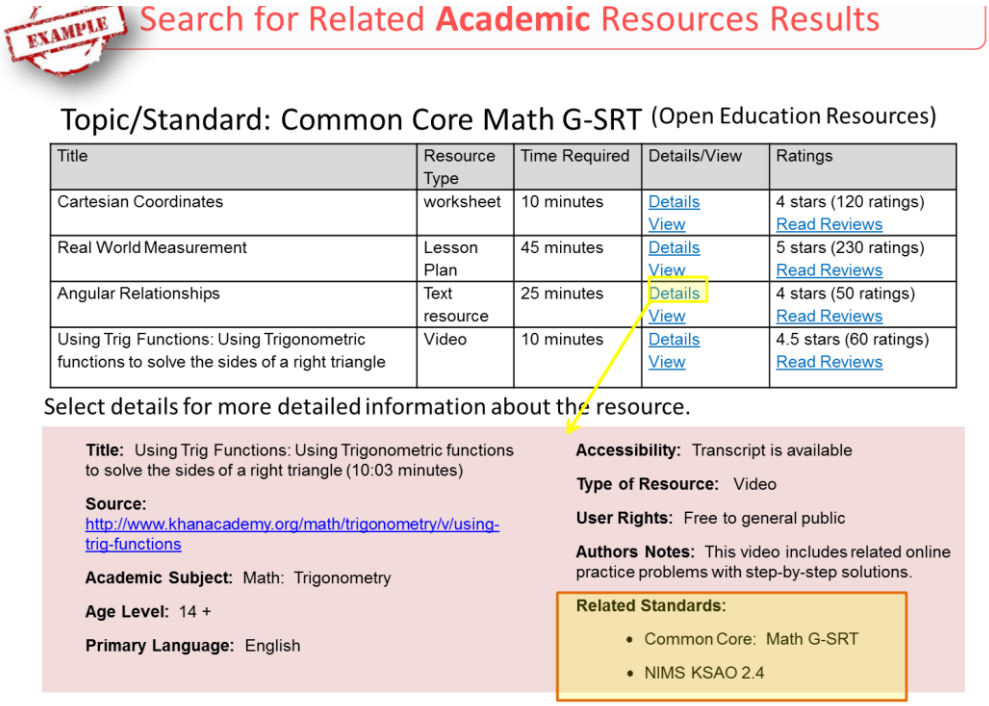
Figure 5 shows that educational resources could be mapped to academic, employability, and technical standards.



Title	Resource Type	Time Required	Details/View	Ratings
Cartesian Coordinates	worksheet	10 minutes	Details View	4 stars (120 ratings) Read Reviews
Real World Measurement	Lesson Plan	45 minutes	Details View	5 stars (230 ratings) Read Reviews
Angular Relationships	Text resource	25 minutes	Details View	4 stars (50 ratings) Read Reviews
Using Trig Functions: Using Trigonometric functions to solve the sides of a right triangle	Video	10 minutes	Details View	4.5 stars (60 ratings) Read Reviews

Figure 6 shows an example of related academic resources cross-walked to employability and technical standards.

Figure 6 - Example of academic resources linked from the CNC Setup and Operation Learning Map.



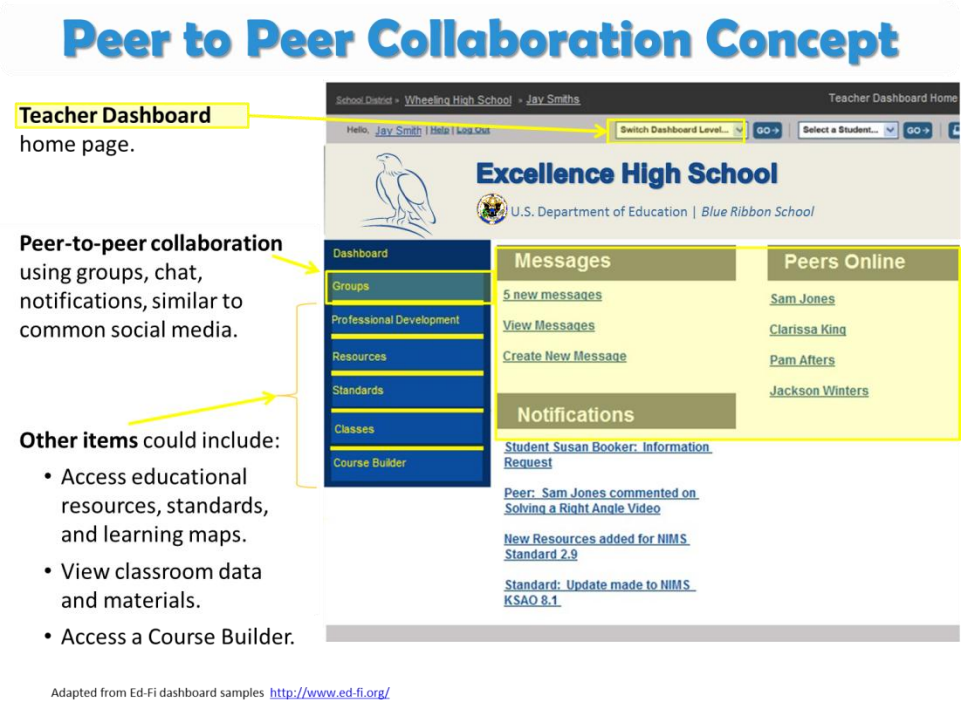
Learning maps can be a powerful tool for helping educators and students personalize learning, meet learning objectives, and achieve them. Student data could also play a role with creating and viewing learning maps based on a student's learning progress.

Portal and Dashboards

The SLC is providing a portal for navigation between applications and dashboards that are used for examining student information based on the Ed-Fi open source technology. The SLC and LR provide the technical infrastructure from which new applications and tools can be created (Shared Learning Collaborative, 2012). Students at all levels, including postsecondary, will greatly benefit if these resources are extended to improve career and technical education (CTE) and workforce development programs. Dashboard applications can be created to have multiple views, to provide real-time information ranging from an individual student and parent perspective, to examine the overall classroom performance to learning maps, course design tools, and recommended resources (Ed-Fi.org, 2012).

As shown with Figure 7, creating a virtual environment that fosters peer-to-peer collaboration by sharing of resources, teaching approaches, and staying current in areas of interest would be highly useful. These dashboard concepts could benefit educators by providing online forums for peer-to-peer collaboration, receiving and sending messages, and receiving notifications about new resource reviews in their interest areas. Educators could participate with discussions, and use comments and feedback similar to the more common social media tools.

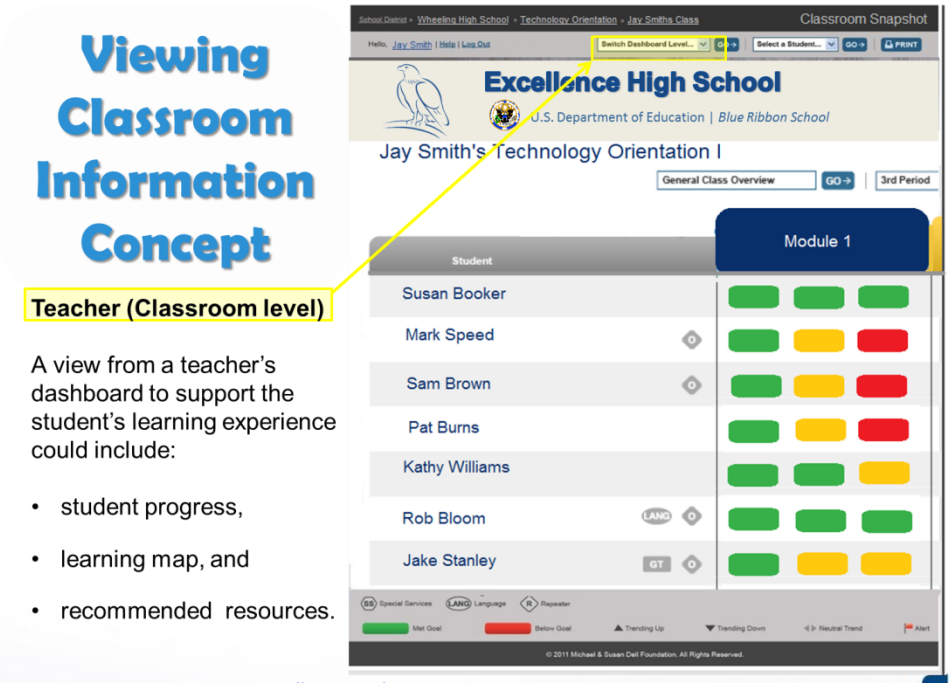
Figure 7 - Example dashboard showing peer-to-peer collaboration for educators.



Adapted from Ed-Fi dashboard samples http://www.ed-fi.org/

Figure 8 shows an example of what a CTE or workforce development program teacher view of classroom level information might look like.

Figure 8 - Example showing a view from a teacher's dashboard of classroom level information.



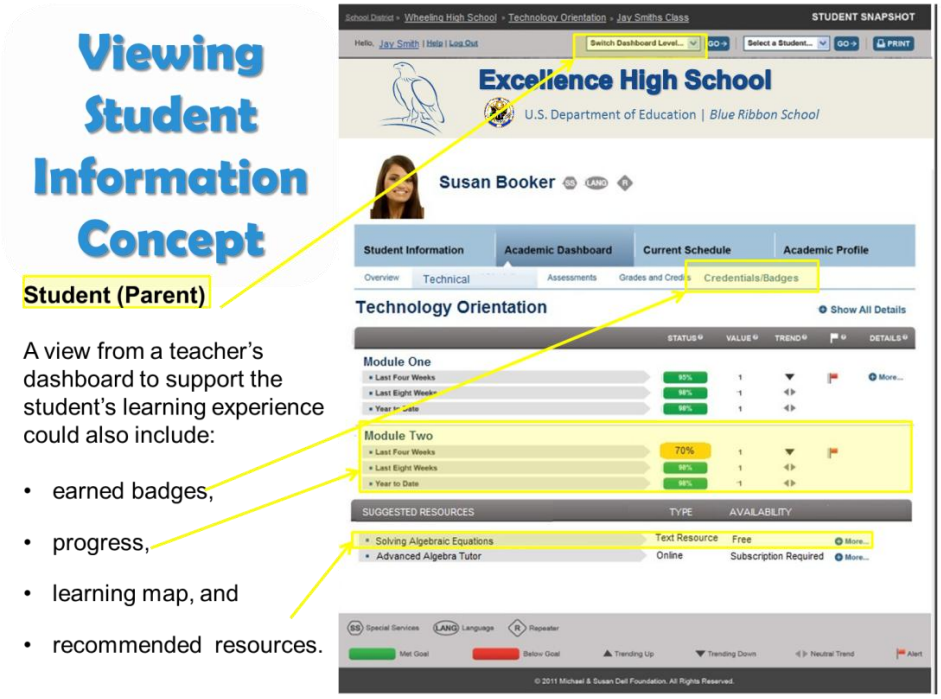
Adapted from Ed-Fi dashboard samples http://www.ed-fi.org/

Dashboard options for students and parents can help reinforce a learner's ability to have an active role in building a personalized learning experience (Ed-Fi.org, 2012). Educators or students could be provided information to improve instruction. For example, options for the personalized learning experience could include:

- Reviewing past performance and credentials or badges earned.
- Examining current progress and recommended resources based on current skill level.
- Using learning maps to see education pathways and skills needed to meet the next benchmark.

Figure 9 shows an example view of a student's information for a Technology Orientation course.

Figure 9 - Example dashboard view showing what student information could look like.



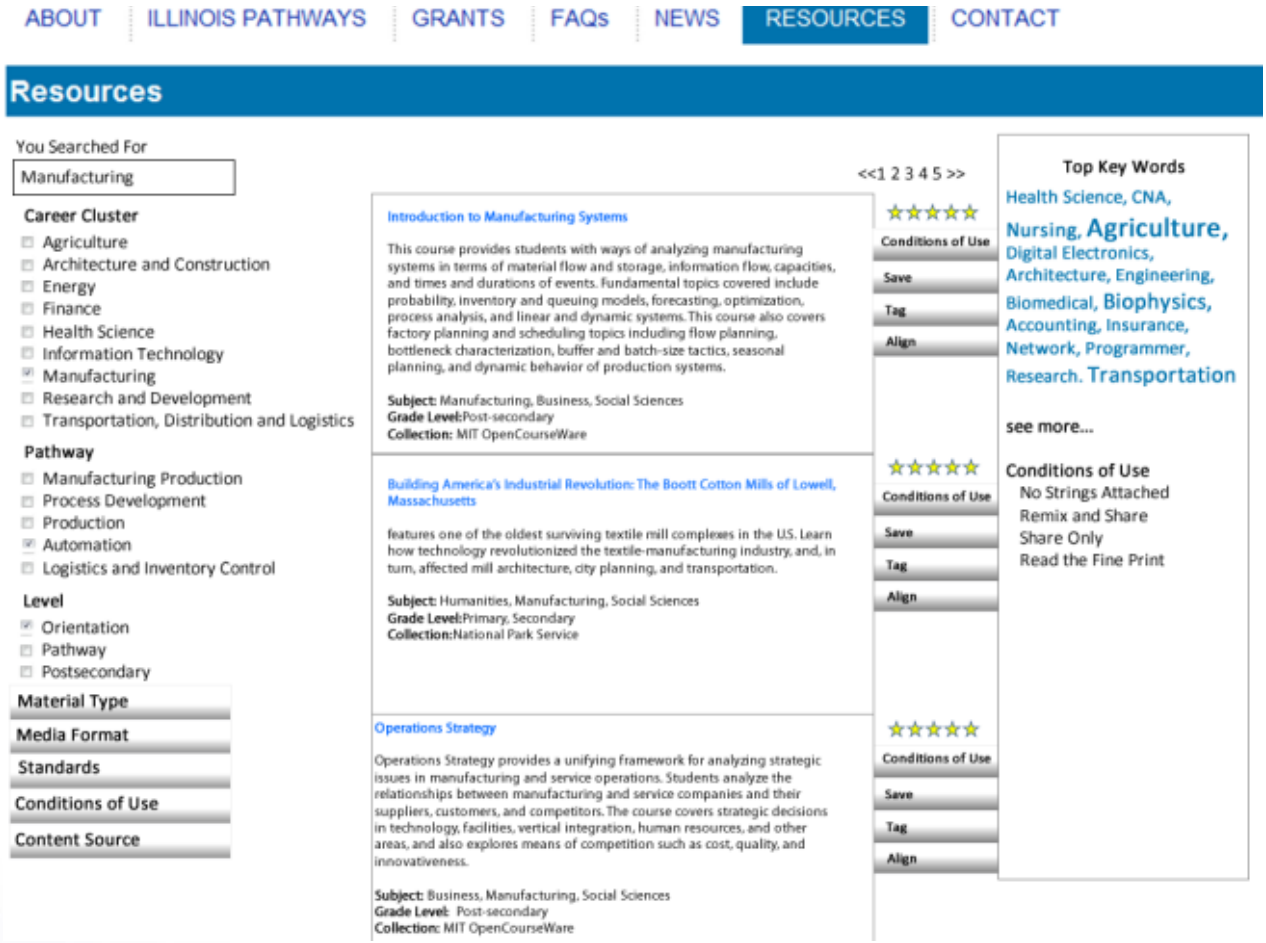
Based on SLC and LR technologies, applications and tools can be developed for creating and updating career and technical education and workforce development: programs, courses, modules, or lesson plans. The Creating Dashboards and Building a Learning Experience tutorial on Illinois Pathways provides a walk-through of a dashboard concept where an educator updates a course called Technology Orientation. The concept shows a step-by-step interface for educators that guides them through setting up a course, module, or lesson. The chart on the next page shows the information that is assembled for the career and technical education course example.

Example Dashboard Application	Example Source of Information for Dashboard Application
Subject area, learning objectives, and grade level.	Illinois Pathway's integration of the nine career clusters and their pathways.
Academic, Employability, and Technical standards to be learned.	States Common Core Standards are already provided by the SLC. Most employability and technical standards are currently not setup to be open or with consistent identifiers (i.e., metadata). There is a need to work with organizations that create employability and technical standards so they will update and create open standards setup with consistent identifiers in machine readable formats. These standards could be integrated with the application so when the educator selects a subject, and a grade level, they are shown as available to be selected and associated with a course, module, or lesson.
Credentials and digital badges that will be earned throughout by successfully completing the course.	Most technical credentials are currently not setup to be open or with consistent identifiers (i.e., metadata). There is a need to work with organizations providing credentials so they will create open access and setup up consistent identifiers in machine readable formats. These credentials could be integrated with the application so when the educator selects a subject, grade level, and standards, they are shown as available to be selected and associated with a course, module, or lesson. Digital badges could be issued by educators, credentialing organizations, career development providers, and many other types of organizations. The LR tagging could include identification of badges associated with courses and many other types of learning opportunities.
OER ranging from worksheets, to videos, to simulations based on the standards and skill level.	SLC integration with LR extended to identify resources in subjects, pathways, and secondary and postsecondary grade levels. This could be available through each school's portal and through integration with the Illinois Pathways website to provide a view open to the public for searching and tagging resources.
OER reviews, usage information, and ratings.	SLC integration with LR extended so users may read and write reviews, rate, and provide information about how resources are used. This could be available through each school's portal and through integration with the Illinois Pathways website to provide a view open to the public for reviewing, rating, evaluating, and contributing resources.
OER side-by-side comparison to select resources best suited to the learning experience.	SLC integration with LR extended to support side-by-side resource comparisons based on usage information, ratings, time to complete, and other information meaningful to educators and students. This could be available through each school's portal and through integration with the Illinois Pathways website to provide a view open to the public for comparing of resources.
Views of the course design including a summary view, detailed view, and a learning map view.	SLC learning map and LR extended to provide CTE and workforce development course, module, and lesson designs based on academic, employability, and technical standards.

Open Access to an OER Search for CTE and Workforce Development Programs

The benefit of open access to helpful technologies and OER should not be limited to schools with access to SLC technologies. Access to OER, including courses, curricula guides, and a wide range of other learning resources needs to be available to the public. Figure 10 shows what a publicly accessible OER search for CTE and workforce development program resources could look like through the Illinois Pathways website. The search provides options for narrowing results by career cluster, pathway, learning level, material type, and more. It shows using ratings, standards alignment, and tags. Users could setup a profile to contribute, rate, comment, tag, and align resources, and save them in folders to easily store and return to them.

Figure10 - Example of a publically accessible search for CTE and workforce development program resources through the Illinois Pathways.



The SLC application tools and LR are providing opportunities to further improve CTE and workforce development. In order for secondary and postsecondary CTE and workforce development programs to fully realize the benefits of the LR, employability and technical standards need to be open and setup to allow for consistent tagging and OER need to be identified and aligned to these standards.

The Common Core State Standards

The States Common Core Standards Initiative is a state-led effort coordinated by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO). Currently, the standards include English and Math. They were developed in collaboration with educators, school administrators, and experts, to provide a clear and consistent framework to prepare students for college and the workforce (States Common Core Standards Initiative). Adoption of these standards by the majority of states ensures that the use of consistent standards will provide appropriate benchmarks for all students, regardless of where they live in the United States. These English and Math standards define the knowledge and skills students should learn in K-12 educational programs so that they will graduate from high school being able to succeed in entry-level, credit-bearing academic college courses and in workforce training programs.

In an effort to provide these standards with unique identifiers so they are used consistently by educators and web applications, the NGA Center and CCSSO have provided metadata guidelines for their use. They have posted a document containing the standards' identifiers and will update their website to provide open machine readable access to them. The unique identifiers include:

- Notation useful for conversation and displayed with the text of a standard (e.g., Math.6.EE.1).
- Dereferenceable uniform resource identifiers (URI). URIs allow individuals and technology systems to validate the content of a standard by viewing the web page at the identifier's URL. A dereferenceable URI is a resource retrieval mechanism that uses any of the internet protocols (e.g., http) to obtain a copy or representation of the resource it identifies. For example, http://corestandards.org/2010/math/content/6/EE/1 or http://corestandards.org/2010/math/practice/MP7
- Unique identifiers to refer to standards in both disciplines in a common format without removing the differences in the published identifiers (e.g., A7D3275BC52147618D6CFEE43FB1A47E).

The metadata vocabulary will be submitted to Creative Commons and schema.org. By providing open and consistent access to and identifiers for, the standards, the SLC and LRI technologies enable educators and content creators to easily and consistently align OER to them. This is an example for any creator or owner of learning standards and can be used to derive steps for addressing the need to identify and make employability and technical standards open, consistent, and interoperable.

Next Generation Science Standards

The National Research Council (NRC), the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve formed a partnership to develop the Next Generation Science Standards (NGSS). Like the States Common Core Standards, the Science Standards are envisioned to be used nationally (Next Generation Science Standards, 2011). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas was released by the NRC in July 2011. The framework identifies the key scientific ideas and practices all students should learn by the end of high school. It served as the foundation for developing new K-12 Science Education Standards with a group of states to replace standards issued more than a decade ago. The timeline to release the standards for state adoption is Fall 2012. The 26 states that participated with development of the NGSS are expected to seriously consider adoption of them. Illinois is among the states to adopt these Science standards.

According to the NGSS team, they plan to release unique metadata tags for each standard around the time the final version of the standards is released.

Extending SLC Benefits to CTE and Workforce Development Programs

CTE and workforce development programs are aligned to academic standards, but central to developing college- and career-ready individuals is education and training that provides career-readiness and technical job skills. Employability and technical standards identify career-readiness and technical skills that build upon academic standards. To fully utilize SLI applications and tools for creating personalized learning, utilizing learning analytics, and using and sharing OER will require aligning States Common Core, employability, and technical standards.

Key Components and Challenges

Identified in the chart on the next page, there are four key components with challenges that need to be addressed to extend the benefits of SLC and other national initiatives to CTE and workforce development.

Key Components	Challenges
1. Employability and technical education standards	• Identifying the range of employability and technical education standards for certifications, to Career Cluster, to state, and informal standards used in CTE Programs. • Using a common structure and format for syntax, and taxonomy guidelines for courses to consistently better prepare students for work and credentials. • Defining metadata to ensure standards can be indexed and tagged to educational resources of all types and for interoperability. • Providing guidance to make the standards more transparent and usable through open and proprietary educational resource tools.
2. Metadata and paradata definitions	• Establishing guidelines for defining, organizing, and cataloging online career and technical education resources to be used with learning maps and resource searches through the LRI.
3. OER availability	• Extending LRI requirements for publishing, consuming, and setting up nodes to deliver career and technical education resources. • Building applications such as course builders and other tools that bring in credentials, standards, and resources that improve program outcomes.
4. Interoperability and data integration	• Providing guidelines for secure integration of: student and performance data; learning maps; standards; credentials; courses; and open and proprietary career and technical education resources.

Nationally, the SLC offers the opportunity to create a roadmap to address the challenges and extend open source technologies and OER to CTE and workforce development programs. Further, creating linkages between academic, technical, and employability standards are beneficial to all educators.

Employability and Technical Learning Standards

The SLC is integrating the States Common Core Standards and providing the framework to include individual states' standards K-12 academic education. CTE and workforce development programs employability and technical standards need to be identified and setup to be usable with the SLI and LR technologies. Below are some examples of standards that are not usable with these technologies in their current formats. This not intended to serve as an inventory of all employability and technical standards but is simply an effort to show the range of standards and lack of them setup to be open and setup with consistent metadata. To make these standards available through extended SLC applications and the LRI, they need to be setup in a consistent usable format that meets national schema standards, be made available online in a machine readable format, and be setup to be interoperable with learning maps.

Employability Standards Examples

These standards are aimed at skills that are necessary across industries, in particular soft skills such as communication skills, attitudes, and team work.

College Readiness Standards for EXPLORE®, PLAN®, and the ACT

ACT's Educational Planning and Assessment System (EPAS) is an integrated series of assessment and career planning programs. Each system is separated by grade levels to include EXPLORE grades 8 and 9, PLAN grade 10, and the ACT for grades 11 and 12. Each assessment is designed to help students increase their academic readiness for college by measuring their achievement in English, Mathematics, Reading, and Science (ACT College Readiness Standards™, 2011). The National Career Readiness Certificate (NCRC) is an industry-recognized, portable, evidence-based credential that certifies essential skills needed for workplace success. This credential is used across all sectors of the economy and verifies the following cognitive skills (National Career Readiness Certificate (NCRC)):

- Problem solving
- Critical thinking
- Reading and using work-related text
- Applying information from workplace documents to solve problems
- Applying mathematical reasoning to work-related problems
- Setting up and performing work-related mathematical calculations
- Locating, synthesizing, and applying information that is presented graphically
- Comparing, summarizing, and analyzing information presented in multiple related graphics

College Readiness Standards are available in a PDF document format for academic subjects including: English, Mathematics, Reading, Science, and Writing.

Equipped for the Future (EFF) Standards

The Work Readiness Credential builds on the solid research foundation of the Equipped for the Future (EFF) Standards Framework, which defines the overall goal of adult learning as helping all adults develop and enhance their skills and knowledge so that they can better carry out their responsibilities as citizens, family members, and workers (EFF, 2012).

Researchers worked with businesses to determine a cross-industry consensus on what new workers in entry-level jobs need to know and be able to do in an effort to define entry-level worker responsibilities for the purpose of building this credential. This consensus is represented in the Work Readiness Credential Profile. As a result, ten entry-level EFF skills are identified as required to carry out 36 entry-level work tasks and behaviors (EFF, 2012). The entry-level skills are identified as:

Communication Skills

1. Speak so others can understand
2. Listen actively
3. Read with understanding
4. Observe critically

Interpersonal Skills

5. Cooperate with others
6. Resolve conflict and negotiate

Decision-Making Skills

7. Use math to solve problems and communicate
8. Solve problems and make decisions

Lifelong Learning Skills

9. Take responsibility for learning
10. Use information and communications technology

Nine of these ten skills are assessed with the Work Readiness Credential assessment package. Passing the assessment means individuals will be able to use these nine skills well enough to carry out the tasks and behaviors identified in the Profile (EFF, 2012).

The standards for these skills are only available by clicking on an interactive skills wheel and by downloading them as PDF format documents from the EEF website (Equipped for the Future Fundamentals - EFF Content Standards).

Industry-Specific Technical Standards Examples

Industry-specific standards have also been developed by various groups to standardize skills and requirements in fields like metalworking, or information technology. The National Institute for Metalworking Skills (NIMS) and CompTIA are two examples of leading providers of professional certifications in their industry.

CompTIA

CompTIA is the leading provider of vendor-neutral certifications in the world, offering 17 certification exams in PC support, networking, servers, convergence, training, Linux, security, IT sales, green IT, and more. CompTIA has been delivering certification exams for more than 15 years, through its commitment to continually improving the service we provide to the industry. In addition to professional certifications, CompTIA supports and leads the global IT industry through education, advocacy, and philanthropy initiatives (CompTIA, 2012).

The IT industry offers a multi-pronged career roadmap in key technology areas for individuals new to the field and IT professionals in transition. The CompTIA website offers lists, brief descriptions, and connections to locations and online courses for preparing and taking credential tests. Their roadmap has some aspects of a learning map, providing a progression of training and credentials needed for IT career advancement. However, they do not provide any industry standards from their website. Training partners agree to use CompTIA-approved curriculum and use instructors that are certified in the CompTIA subjects they teach. In return, CompTIA offers bulk certification voucher discounts, joint marketing and sales support, and exclusive bundled solutions

DOL Industry Competency Model Clearinghouse

Sponsored by the U.S. Department of Labor, the Competency Model Clearinghouse provides validated industry competency models and tools to build a custom model and career ladder/lattice for industry. The industry competency models promote an understanding of the skill sets and competencies that are essential to educate and train a globally competitive workforce (DOL Competency Model Clearinghouse, 2012).

Models are organized as blocks, where each competency builds upon the other. Personal Effectiveness Competencies such as Integrity and Professionalism are foundational components. Academic Competencies such as reading and math, build upon personal effectiveness. Workplace competencies such as creative thinking and team work are crucial pieces to career and professional development.

Industry-wide technical competencies are then included based on requirements of a specific industry. Industry specific examples are provided for several industries such as Advanced Manufacturing, Bioscience, Energy, and Retail. A full list of industries can be viewed on the Career One Stop, Competency Model Clearinghouse web page. Design and Development is just one industry-wide technical standard for Automation; while Automation Fundamentals such as systems processes, applications, and standards supporting the design and application of automation would be examples of Industry Sector Technical Competencies. Occupational Specific Requirements and Management are the last of the competencies.

The competency models are available online by clicking on interactive building block graphics. The Competency Model Clearinghouse also offers two tools designed to help businesses, educators, and workforce professionals achieve their talent development goals:

1. The Build a Competency Model Tool guides people through the development of a competency model that identifies the knowledge, skills, and abilities needed to perform successfully in an industry.
2. The Build a Career Ladder/Lattice Tool is used to create career ladders or lattices that outline critical experiences individuals need to progress through a career in an industry.

The competency statements are not setup to be used by other web applications, only to be viewed from the U.S. Department of Labor sponsored website.

International Technology and Engineering Educators Association

The International Technology and Engineering Educators Association (ITEEA) is the professional organization for technology, innovation, design, and engineering educators. Their mission is to promote technological literacy for all by supporting the teaching of technology and engineering and promoting the professionalism of those engaged in these pursuits (ITEEA). They have published, *Standards for Technological Literacy: Content for the Study of Technology.* According to ITEEA, these standards represent what every person should know and be able to do in order to be technologically literate. Access to these standards is limited only to several downloadable PDF documents that define and list standards. A listing of these standards is shown below (ITEEA K-12 Standards).

Listing of ITEEA standards for technological literacy:

The Nature of Technology
- Standard 1. Students will develop an understanding of the characteristics and scope of technology.
- Standard 2. Students will develop an understanding of the core concepts of technology.
- Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Technology and Society
- Standard 4. Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5. Students will develop an understanding of the effects of technology on the environment.
- Standard 6. Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7. Students will develop an understanding of the influence of technology on history.

Design
- Standard 8. Students will develop an understanding of the attributes of design.
- Standard 9. Students will develop an understanding of engineering design.
- Standard 10. Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World
- Standard 11. Students will develop abilities to apply the design process.
- Standard 12. Students will develop abilities to use and maintain technological products and systems.
- Standard 13. Students will develop abilities to assess the impact of products and systems.

The Designed World
- Standard 14. Students will develop an understanding of and be able to select and use medical technologies.
- Standard 15. Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
- Standard 16. Students will develop an understanding of and be able to select and use energy and power technologies.
- Standard 17. Students will develop an understanding of and be able to select and use information and communication technologies.
- Standard 18. Students will develop an understanding of and be able to select and use transportation technologies.
- Standard 19. Students will develop an understanding of and be able to select and use manufacturing technologies.
- Standard 20. Students will develop an understanding of and be able to select and use construction technologies.

National Career Clusters™ Knowledge and Skills Statements and Common

In cooperation with the National Career Technical Education Foundation (NCTEF), the National Association of State Directors of Career Technical Education Consortium (NASDCTEc) provides leadership and support for the National Career Clusters™ Framework to deliver high-quality CTE programs through improved curriculum design and instruction. Their goal is to elevate student success in college and career while strengthening the economy and driving America's competitiveness worldwide (CTE, 2012). To support use of the framework for secondary and postsecondary education, each career cluster has Knowledge and Skills Statements, which are an equivalent of learning standards. The Pathway Knowledge and Skills Statements were updated during 2008 and are currently under revision with the plan to make them available during 2012. Additionally, during June 2012, the NASDCTEc made new Common Career Technical Core (CCTC) Standards available to the public.

The Pathway Knowledge and Skills Statements are for each of the following career clusters:

1. Agriculture, Food and Natural Resources
2. Architecture and Construction
3. Arts, A/V Technology and Communications
4. Business Management and Administration
5. Education and Training
6. Finance

7. Government and Public Administration
8. Health Sciences
9. Hospitality and Tourism
10. Human Services
11. Information Technology
12. Law, Public Safety, Corrections and Security
13. Manufacturing
14. Marketing
15. Science, Technology, Engineering and Mathematics
16. Transportation, Distribution and Logistics

They include four parts:

1. Foundational Academic Expectations - All secondary students should meet their state's academic standards. All Essential Cluster and Pathway Knowledge and Skills are predicated on the assumption that foundational academic skills have been attained. Some Knowledge and Skill statements will further define critical linkages and applications of academics in the cluster and/or pathway.
2. Essential Knowledge and Skills - The Knowledge and Skills statements apply to careers in all clusters and pathways. Persons preparing for careers in a pathway should be able to demonstrate these skills in the context of the cluster and pathway.
3. Cluster (Foundation) Knowledge and Skills - The Cluster (Foundation) Knowledge and Skill statements apply to all careers in a career cluster. Persons preparing for a career cluster should be able to demonstrate these skills in addition to the Essential Knowledge and Skills.
4. Pathway Knowledge and Skills - The Knowledge and Skills statements apply to careers within pathways.

The CCTC standards are an overarching set of Career Ready Practices that apply to all programs of study. Career Ready Practices describe the career-ready skills that educators should seek to develop in their students. These practices are not exclusive to a Career Pathway, program of study, discipline or level of education. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study (Common Career Technical Core, 2012).

The following 12 statements are Career Ready Practices that address the knowledge, skills and dispositions identified as important to becoming career ready:

1. Act as a responsible and contributing citizen and employee.
2. Apply appropriate academic and technical skills.
3. Attend to personal health and financial well-being.
4. Communicate clearly, effectively and with reason.
5. Consider the environmental, social and economic impacts of decisions.
6. Demonstrate creativity and innovation.
7. Employ valid and reliable research strategies.
8. Utilize critical thinking to make sense of problems and persevere in solving them.
9. Model integrity, ethical leadership and effective management.
10. Plan education and career path aligned to personal goals.
11. Use technology to enhance productivity.
12. Work productively in teams while using cultural/global competence.

NASDCTEc is in the process of creating unique identifiers associated with the standards, performance elements, and sample indicators. An online database is currently being finalized that will allow for searching, sorting, and adhoc reporting that will include an option to download Comma Separated Value (CSV) files. This file format is commonly opens as a spreadsheet. The completion of this phase of the project is anticipated to be done by mid-July (Folkers, 2012).

The format will be a slightly different than the previous Knowledge and Skills work, but essentially will look like the following:

AG1 Agriculture Cluster level standard one
AG1.1 Agriculture Cluster level performance element one under standard one
AG1.1.1 Agriculture Cluster level sample indicator under performance element 1 under standard one

The following is an excerpt from the current Manufacturing Cluster Production Pathway Knowledge and Skills Statement (spreadsheet) shows the Knowledge and Skills statements organized under Quality Processes. Persons preparing for careers in the Manufacturing Cluster should be able to demonstrate these skills in addition to those found on the Essential Knowledge and Skills Chart (CTE, 2012).

Pathway Topic MNPB01	QUALITY PROCESSES
MNPB01.01	**Recognize and correct production processes to assure that products meet production quality standards.**
MNPB01.01.01	Communicate quality problems following the appropriate reporting process.
Sample Indicators	Review quality problems with production operators.
	Communicate quality problems promptly to appropriate parties.
	Use established processes to document quality problems.
	Summarize defect trends and report them to appropriate parties.
MNPB01.01.02	Suggest or perform corrective actions to correct quality problems.
Sample Indicators	Make minor quality issues/adjustments immediately.
	Document quality issues or adjustments properly.
	Make sure that recommendations for action are clear and concise, and supported by data.
	Make recommendations in a timely way to appropriate parties.
	Document follow-up activities and indicate that corrective action was taken.
	Document product quality following corrective action.
MNPB01.01.03	Determine appropriate action for sub-standard product.
Sample Indicators	Execute quality control procedures to catch sub-standard products promptly within the z defined quality systems.
	Document decisions regarding sub-standard products for future retrieval.
	Process sub-standard products according to company policy.
	Distribute documentation required for customers to appropriate parties.
MNPB01.01.04	Identify trends using records of process outcomes.
Sample Indicators	Maintain records on quality process to appropriate standards.
	Chart outcomes of quality processes according to appropriate methods and standards.
	Check data on quality processes for accuracy.
	Analyze quality process performance data to identify trends.
	Report quality process performance data to appropriate parties in a timely way.
MNPB01.01.05	Recognize needed adjustments using records of process outcomes.
MNPB01.01.06	Identify performance and training issues.

Pathway Topic MNPB01	QUALITY PROCESSES
MNPB01.01.07	Prepare reports regarding performance and training issues.
MNPB01.01.08	Assess the effect of performance and training issues on production quality.
MNPB01.01.09	Implement closed-loop corrective action to provide for ongoing production feedback.
Sample Indicators	Document evidence of corrective action in a timely manner.
	Report change resulting from the corrective action to appropriate parties in the correct format.
	Use spot checks to verify implementation of the corrective action.
	Store reports properly for the required amount of time.
	Perform ongoing audits to optimize the outcomes of the corrective actions.
	Examine previous documentation on similar process issues to identify possible solutions.

National Institute for Metalworking Skills

National Institute for Metalworking Skills (NIMS) has developed skills standards in 24 operational areas covering the breadth of metalworking operations including Metal Forming (e.g., Stamping, Press Brake, Roll Forming, Laser Cutting) and Machining (e.g., Machining, Tool and Die Making, Mold Making, Screw Machining, Machine Building and Machine Maintenance, Service and Repair). The Standards range from entry (Level I) to a master level (Level III). All NIMS standards are industry-written and industry-validated, and are subject to regular, periodic reviews under the procedures accredited and audited by the American National Standard's Institute (NIMS, 2012). These standards are only available for purchase. However, Google searches will turn up schools that have posted NIMS standards to their websites as PDF documents.

An excerpt is shown below from The National Institute for Metalworking Skills, Inc., Duties and Standards for Machining Skills-Level I, NIMS/ANSI 101-2001, Copyright July 1997-Revised September 2001.

NI 17 Duty Area: 1. Job Planning and Management

Duty Title: 1.1 Job Process Planning
Duty: Develop a process plan for a part requiring milling, drilling, turning, or grinding. Fill out an operation sheet detailing the process plan and required speeds and feeds.

Performance Standard: Given a print detailing a part requiring milling, drilling, turning, and grinding, verbal instructions, and appropriate references, formulate a set of strategies to manufacture the part and fill out an operation sheet reflecting the chosen strategies including the required speeds and feeds.
Identify all major components and functions of the machine tools, and all major hand tools, measuring tools, tools and fixtures, work materials and provide the rationale for the speeds and feeds selected.
Note: The blueprint will require the execution of the machining operations described in duties 2.1 to 2.9.
Other Evaluation Criteria:1. Legibility and 2. Appropriate speeds and feeds
Accuracy Level: N/A.
Assessment Equipment and Material:
Workstation: Common workbench.
Material: A print with an appropriate part, an inventory of available tools.
Tooling: N/A.
Measuring Instruments: N/A.
Reference: Machinery's Handbook.

KSAO: Knowledge, Skills - This table represents the kinds of knowledge, skills, abilities, or other characteristics that will be assessed in the performance of the Job Process Planning Duty.

	1. Written and Oral Communication		5. Engineering Drawings and Sketches
X	1.1 Reading	X	5.1 Standard Orthographic Prints
X	1.2 Writing		5.2 GDT Orthographic Prints
X	1.3 Speaking	X	5.3 GD&T Datums, Symbology and Tolerances
X	1.4 Listening		6. Measurements
	2. Mathematics	X	6.1 Basic Measurements
X	2.1 Arithmetic	X	6.2 Precision Measurements
X	2.2 Applied Geometry		6.3 Surface Plate Instruments
X	2.3 Applied Algebra	X	6.4 Metric Conversion
	2.4 Applied Trigonometry		7. MetalworkingTheory
	2.5 Applied Statistics	X	7.1 Cutting Theory
	3. Decision Making and Problem Solving	X	7.2 Tooling
X	3.1 Applying Decision Rules	X	7.3 Material Properties
X	3.2 Basic Problem Solving	X	7.4 Machine Tools
	4. Group Skills and Personal Qualities	X	7.5 Cutting Fluids and Coolants
	4.1 Group Participation and Teamwork		
	4.2 Personal Qualities		

Creating a Roadmap and Implementing a Plan of Action

A national, multi-state initiative needs to be convened with the U.S. Department of Education and U.S. Department of Labor to design steps and guidance for extending powerful technology tools to benefit CTE and workforce development programs. This initiative should engage key organizations including:

- Organizations actively developing OER guidelines and delivery tools
- Industries that hire skilled workers and benefit from career and technical education
- Credentialing organizations that provide employability and technical competencies or standards
- Workforce and academic educators
- Government agencies

This national, multi-state initiative can begin with the following steps:

1. Build national awareness and consensus on the need for this initiative.
2. Establish a national steering group of key stakeholders to develop white papers and guidelines for managing and extending the SLC technical infrastructure to include:
    a. Providing schema similar to academic standards but reflecting more complex competencies including those connected to industry certifications.

b. Defining metadata for open education and proprietary resources.

3. Identify industry sectors to demonstrate the feasibility and benefits of using these guidelines.
4. Establish a feedback loop for revising guidelines and launching additional sector initiatives.
5. Create a sustainability plan for maintaining national infrastructure.

The Big Picture: Understanding the Key Components

The SLC is bringing together nationally available resources and technologies. Each one plays an important role. To understand the challenges and benefits to secondary and postsecondary CTE and workforce development programs, it is necessary to be familiar with the source of these resources and technologies. The chart below identifies key inputs to SLC from national organizations:

National Organization	What They Do	Role with SLC/SLI
Achievement Standards Network (ASN)	Structuring metadata for machine readable standards and providing global access to them.	Learning standards used with learning maps can use the identifiers assigned by the ASN.
Creative Commons	Provide infrastructure and tools for issuing attribution licenses that protect resource creators but allow OER to be used in various ways.	Educational resource creators and publishers who make their works available to the SLC through the tagging tool or through their own websites, can use Creative Commons attribution licenses to protect their works but also to allow use of them for educational purposes.
Ed-Fi	Developed standards and open source technologies for student data integration and dashboards for viewing student performance metrics.	The SLC is using the Ed-Fi open educator dashboards and data specifications to integrate student and classroom-level data.
Learning Registry Index (LRI)	Created an online platform that allows the educational community to publish and consume OER.	Integrates with SLI to connect learning maps to resources, allow for searching and tagging of academic resources, and aligning of academic standards.
Learning Resource Metadata Initiative (LRMI)	Provide a standard vocabulary for describing learning resources.	SLC is using standardized metadata from the LRMI and Schema.org.
Mozilla Open Badge Infrastructure (OBI)	Mozilla, with several foundations, is leading efforts to standardize use of metadata for issuing, displaying, and sharing digital badges.	Although not being released with the initial SLI components, because the SLI supports extendibility, there is potential for issuing or storing earned badges.
OER Commons	Provide a website for finding, tagging, rating, evaluating, contributing, and aligning OER to States Common Core Standards.	As a LRI resource contributor, educators will benefit from the OER this site tags and aligns to States Common Core Standards.
Schema.org	Standardizes structured data markup schema supported by major search engines.	SLC is using standardized metadata from the LRMI and Schema.org.

Each of these sources is described in the following sections of this paper.

Achievement Standards Network

The Achievement Standards Network (ASN), in collaboration with the Global Learning Resource Connection (GLRC), is providing a specification for learning standards with unique, web-resolvable identifiers (URI). It has been structured to support standards text, metadata, and mapping across educational areas and industries (Achievement Standards Network (ASN)). Simply stated, metadata describes learning standards so web applications can use them. They offer tools for anyone to browse and download standards they have already setup in machine readable formats including the States Common Core and state academic standards. The Resource Description Editor (RDE) is a tool available upon request to transform any learning standard into metadata. Some web services are also provided to application developers to integrate their standards data. Their data is free for use under a Creative Commons license. Both the SLC and the LRI are using ASN metadata as a source for standards.

At the moment, the ASN is concentrating on state academic standards (Math, ELA, Science, Social Studies, The Arts) and select national standards (e.g., States Common Core and National Council for Teachers of English/ International Reading Association). According to ASN, their data model can accommodate any type of standards including employability and technical standards, and for a fee they could provide access to these in machine readable formats.

Creative Commons

OER and open source technologies provided through web applications like ASN, OER Commons, and the LRI, use Creative Commons licenses. The idea of universal access to research, education, and culture is made possible by the Internet, but our legal and social systems don't always allow access to be realized. Copyright laws were created long before the emergence of the Internet, and can make it hard to legally perform actions we take for granted on the network: copy, paste, edit source, and post to the Web. The default setting of copyright law requires all of these actions to have explicit permission, granted in advance, whether you're an artist, teacher, scientist, librarian, policymaker, or just a regular user.

To achieve the vision of universal access, Creative Commons provides a free, public, and standardized infrastructure that creates a balance between the Internet and copyright laws. Their tools give everyone from individual creators to large companies and institutions a simple, standardized way to grant copyright permissions to their creative work. The combination of their tools and users is a vast and growing digital commons, a pool of content that can be copied, distributed, edited, remixed, and built upon, all within the boundaries of copyright law.

Creative Commons offers several attribution license options, each includes legal code, is human readable, and machine readable. This ensures that creators and users understand how OER can be used.

Ed-Fi

The Ed-Fi is an XML-based universal data standard that facilitates data exchange among student data systems in the K-12 education sector. Development was funded by the Michael & Susan Dell Foundation based on input from vendors, state education agencies and local education agencies. The Ed-Fi has developed open source technologies, including a data exchange standard that unifies student performance data from disparate systems, and a toolkit for building customized, user-friendly dashboards that provide actionable information to educators. To encourage nationwide adoption, the Foundation offers free, non-transferable licenses for all the Ed-Fi components.

The extensibility of the Ed-Fi data standard means that virtually any information systems that collect, manage, report on, or provide analysis of student data can be unified. These include, but are not limited to, student information systems, grade book applications, curriculum and lesson planning systems, and benchmark testing and reporting systems. The kinds of data exchanged among these systems might include, for instance, records on students' grades, absence rates, transcripts and standardized test scores. The Ed-Fi can also unify other operational systems including accounting and human resource systems.

The Ed-Fi core schema includes over 400 data elements, and the flexibility to add more as necessary. The Ed-Fi enables these elements to be combined to accommodate continuously evolving accountability and performance metrics. This flexibility means the Ed-Fi can support current reporting needs and adapt to future ones. The definition of graduation rate, for example, is calculated by different states using up to nine data elements, such as entry date, entry grade level, withdraw date, and withdraw reason, which are typically dispersed across multiple information systems.

The Ed-Fi solution shares some characteristics with other established and emerging educational standards, such as Common Education Data Standards (CEDS), schools interoperability framework (SIF), Post-Secondary Education Standards Council (PESC), national education data model (NEDM) and National Center for Education Statistics (NCES). However, the Ed-Fi also supports a more teacher- and student-centric goal than these other standards, none of which focuses on the specific goal of improving student outcomes. The Ed-Fi does not replace other existing standards. It complements and enhances them; first, by sharing disparate data and translating it into element-level detail, and second, by offering broad coverage at the school, district, or state level.

The SLC is using the Ed-Fi open educator dashboards and data specifications to integrate student and classroom-level data.

Learning Registry Index (LRI)

Educators have long been challenged with identifying individual student needs, in a limited timeframe. Teachers are tasked with finding course and content resources that are aligned to learning standards, while meeting an individual student's learning style needs—neither of which is simple to do in a typical school day. To help address this issue, the LRI is an open source technical system designed to facilitate the exchange of data behind the scenes. It is 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 Internet (Hobson & Lee, 2012).

It is a new approach to capturing, sharing, and analyzing resource data to broaden the usefulness of digital content to benefit educators and students. It is comprised of a community of organizations dedicated to the study, spread, and strategic use of knowledge management in education (Learning Registry). The LRI is only as good as the information that is contributed to it. It does not identify which resources align to what standards; it relies on its publishers to provide this information. This information is stored as metadata or paradata, which is searchable by keyword and identifies standards and related resources. For learning resources to be discovered, they must be tagged. These data include, but are not limited to: title, description, use right, end-user role, time, standard, resource type, and grade level.

While Google is the most frequently used search engine in the world, it does not necessarily include commenting and tagging to standards, or validation that the information shared was submitted by a trusted source. The LRI is designed to be a collaborative effort by resource creators, publishers, and educators—resulting in a higher percentage of quality resources for educators and students.

The LRI integrates with SLI to connect resources to learning maps and for searching and tagging of academic resources aligned to academic standards. Standard tags are needed for CTE and workforce development program subjects, permitting the LRI publishers and contributors to contribute educational resources and align them to competencies and skills, role performance and job duties, and cross-pathway performance standards.

Learning Resource Metadata Initiative (LRMI)

The LRMI is a project led by Creative Commons (CC) and the Association of Educational Publishers (AEP) to establish a common vocabulary for describing learning resources. The vocabulary will be the first independently developed industry-specific framework addressing education that is designed to work with schema.org. The web metadata framework launched June 2, 2011 by Google, Bing, and Yahoo! was designed to improve the practical search and discovery of learning resources online. A common framework for tagging and organizing learning resources can enable further applications; thus, in order to maximize use and the realization of future benefits for all learners, interoperability and transparency will be key criteria for the vocabulary and LRMI's development process. The LRMI vocabulary is also intended for use with other metadata frameworks. For example, LRMI is expected to be used with the SLC integration of the LRI (Learning Resource Metadata Initiative (LRMI) – RFP Guidance, 2012).

Mozilla Open Badge Infrastructure (OBI)

Mozilla, in partnership with other foundations, is leading an initiative to increase access to and provide infrastructure for sharing of digital badges. Mozilla is developing Open Badge Infrastructure (OBI), a specification that allows for learners to collect and display badges from multiple issuers. The OBI isn't a badge issuing platform, badge issuers need systems that assess learning and award badges within their own site.

A badge is a validated indicator of accomplishment, skill, quality, or interest that can be earned in any environment. Badges can support learning, validate education, help build reputation, and confirm the acquisition of knowledge (Digital Media and Learning Competition - Badges for Lifelong Learning, 2012). They can signal traditional academic attainment or the acquisition of skills such as collaboration, teamwork, leadership, and other 21st century skills.

Traditionally, badges have been represented in the form of items such as Girl Scout badges, Boy Scout badges, academic pins, sports pins, military medals, and years of service pins for some employers. You can also think of badges as a traditional certificate of completion, diploma, or award. Advances in technology and gaming have made the use of digital badges popular. A *digital badge* is an online record of achievements, the work required, and information about the organization, individual, or other entity that issued the badge. Badges make the accomplishments and experiences of individuals, in online and offline spaces, visible to anyone and everyone, including potential employers, teachers, and peer communities (Digital Media and Learning Competition - Badges for Lifelong Learning, 2012).

OER Commons LRI Example

OER Commons foster open sharing of resources and knowledge that can support improvements in teaching and learning. The Institute for the Study of Knowledge Management in Education created OER Commons to provide support for and build a knowledge base around the use and reuse of OER.

The OER Commons network is a curated collection of over 32,260 educational resources—including open textbooks—that can be shared, adapted, and remixed to fit individual teaching and learning needs. Thousands of materials are available by topics, such as Science & Technology (17276), Mathematics & Statistics (4811), and Humanities (7052). Resources are also available for CTE where users explore vocational OER to build general skills, plan their career, and develop marketable skills.

The sites' resources are organized and available for primary, secondary, and post-secondary grade levels. Several material types are tagged including: syllabi, homework and assignments, curriculum standards, lesson plans, courses, and more. Materials are organized in alphabetical order by topic and can be sorted based on subject area, activity type, grade level, media format, and content source. Each resource is equipped with tagging, rating, evaluating, sharing, and Common Core Standards alignment tools, indicating the appropriate use for each resource. Trending topics can be viewed as well, identifying top utilized subject areas or topics.

The OER Commons website is a contributor to the LRI. As a contributor to the LRI, the tagged and standards-aligned resources metadata and paradata can become available to any other website or application that uses LRI data.

Schema.org

Schema.org is a joint effort sponsored by Google, Inc., Yahoo, Inc., and Microsoft Corporation to improve the web by creating a structured data markup schema supported by major search engines. On-page markup helps search engines understand the information on web pages and provide richer search results. A shared markup vocabulary makes it easier for webmasters to decide on a markup schema and get the maximum benefit for their efforts. Search engines want to make it easier for people to find relevant information on the Web. Markup can also enable new tools and applications that make use of the structure (Schema.org FAQs). On-page markup enables search engines to understand the information on web pages and provide richer search results in order to make it easier for users to find relevant information on the web.

This site provides a collection of schemas (i.e., html tags), that webmasters can use to markup their pages in ways recognized by major search providers. Search engines including Bing, Google, and Yahoo! rely on this markup to improve the display of search results, making it easier for people to find the right web pages. Some of the commonly used schemas include:

- Creative works: CreativeWork, Book, Movie, MusicRecording, Recipe, TVSeries
- Embedded non-text objects: AudioObject, ImageObject, VideoObject
- Event
- Organization
- Person
- Place, LocalBusiness, Restaurant ...
- Product, Offer, AggregateOffer
- Review, AggregateRating

Any of the open schemas are available for use under a Creative Commons license.

Glossary

application program interface (API) - specification intended to be used as an interface by software components to communicate with each other. An API may include specifications for routines, data structures, object classes, and variables.

career and technical education (CTE) - Prepares both youth and adults for a wide range of careers and further educational opportunities. These careers may require varying levels of education—including industry-recognized credentials, postsecondary certificates, and two- and four-year degrees.

Comma Separated Values (CSV) Format - A comma-separated values file stores tabular data (numbers and text) in plain-text form.

Common Education Data Standards (CEDS) - 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.

JSON format - JavaScript Object Notation, is a lightweight text-based open standard designed for human-readable data interchange.

learning map - Learning maps are a graphical representation of student learning that will help educators and students visualize student learning progress and needs.

metadata - Metadata is information describing a learning resource, such as its location, publication date, author, and the learning standard alignment. Metadata takes the form of tags, markers, or fields that help identify all manner of descriptive, administrative, and technical information about a given object. A metadata record consists of a standardized set of properties, or tags, that provide a necessary structure for describing a resource or collection of resources.

multitenant data store - The Shard Learning Collaborative technology will include a secure, multitenant, cloud-hosted data store designed to help states and districts manage student enrollment and achievement information that is currently housed in multiple systems.

Open Educational Resources (OER) - OERs are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. OERs include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge.

open source technologies - Open source is a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in.

paradata - Paradata is a specialized type of metadata which describes how a resource is or has been used. Paradata helps communicate when you want to talk about how people have used a book or other resource. It includes statements about a resource consisting of three parts: an actor, a verb, and an object.

- Actor - refers to the person or group who does something with the resource.
- Verb - describes the action of actor.
- Object - refers to the resource being acted upon. The important part of an object is the URL where you can find out about the object.

Resource Description Editor (RDE) - a tool available to transform a learning standard into metadata.

Schema - A representation of a plan or theory in the form of an outline or model.

Shared Learning Infrastructure (SLI) - The SLC is building a set of shared technology services that will allow states and districts to connect student data and education materials that currently exist in different formats and locations, in order to integrate them effectively for educators, parents, and students. The shared technology services are also known as the Shared Learning Infrastructure (SLI).

software development kit (SDK) - A set of software development tools that allows for the creation of applications for a certain software package, software framework, hardware platform, computer system, video game console, operating system, or similar platform.

tagging - Tagging is the act of creating and publishing a resource description for resources. The description is created by identifying associated metadata or paradata.

uniform resource identifier (URI) - A string of characters used to identify a name or a resource. Such identification enables interaction with representations of the resource over a network (typically the World Wide Web) using specific protocols. Schemes specifying a concrete syntax and associated protocols define each URI.

workforce development - Programs that participate with preparing college- and career-ready workers with employability and technical job skills.

XML - Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. The design goals of XML emphasize simplicity, generality, and usability over the Internet.

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