### Smithsonian Center for Education and Museum Studies Digital Learning Resources Project

Volume V Final Report October 2012 v. 1.0



Smithsonian Center for Education and Museum Studies

# **CROSS & JOFTUS**



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#### Preface

The Internet and web together have sparked a revolution in our society that has had a profound impact on the education community. The current funding crisis in education, combined with rapid advances in technology – in communications and content sharing – are challenging our relationships with information and learning and positioning us on the threshold of a new era (Kratz & Merritt. 2011). Informal learning experiences that incorporate web technology such as social media are growing at a rapid pace and are considered by organizations like the National Science Foundation (NSF) to be a natural bridge to school learning (Bull, Thompson et al., 2008).

There is a good deal of consensus around standards for teaching and learning and the core set of skills needed for academic success in the 21<sup>st</sup> century. Museum educators are uniquely positioned to help usher in this new era if they are prepared to operate more ubiquitously within the digital space and create an online presence by exposing collections to broader audiences and providing tools that foster 21<sup>st</sup> century learning skills (Kratz & Merritt, 2011). At present, 45 states and 3 territories have adopted our nation's Common Core Standards, and school systems in these states are aligning or have aligned their curricula to ensure that America's students acquire the necessary skills to remain competitive in our global marketplace.<sup>1</sup> The Next Generation Science Standards<sup>2</sup>, (released 2012) also provide a framework for how teachers should build learning experiences that: foster connections; create coherence (i.e. organized around core explanatory ideas or questions that kids use to make sense of the world around them); are multidisciplinary; are relevant to students' lives.

In this context, it is incumbent upon a leading institution like the Smithsonian, and particularly the Smithsonian Center for Education Museum Studies (SCEMS), to review and renew its approach to providing digital access and support, hence the *Digital Learning Resources Project*. As you will read in the following report and its companion volumes, much that was already known was confirmed in this process, and much was learned. Most importantly, however, the *Digital Learning Resources Project* (DLRP) revealed to researchers in very specific ways, grounded in research and tested in targeted ways by teachers, what the next generation digital toolset for smithsonianeducation.org can and should do. It revealed how the carefully conceived prototypes, if developed, can help teachers to more effectively identify, analyze and extract specific Smithsonian digital learning content, increasing their skills and making strategic use of digital media and visual displays of data to express information and enhance understanding as well as increase the creativity of their teaching.

<sup>&</sup>lt;sup>1</sup> See: http://www.ccsso.org

<sup>2</sup> http://www.nextgenscience.org/about-standards-development-process

SCEMS can now position itself as a definitive source of educator-use expertise that works to inform pan-Smithsonian digital learning efforts. This is, and will continue to be, an area of expertise needed across all units making use of common tools, accessing common data and repositories through unique content collections, and it is most suited to the existing design, directives, and configuration of the Smithsonian Center for Education and Museum Studies.

Foundational to developing this position will be the continued coordination of internal documentation and digitization strategies tied to ongoing Smithsonian units and their respective assets. The ability to access and translate machine-readable constructs of the metadata from those efforts as a means to integrate intuitive search and assimilation processes will create opportunities for more sophisticated tool development.

When creating and deploying the data-enriched tools as envisioned here, SCEMS should look to not merely publish them as just resident items within their own SCEMS system but also as portable utilities, easily surfaced in other unit's web environments.

And finally, to promote this work abroad and increase external visibility, SCEMS can now provide the technical means to broadcast user-generated content and data with these tools across educators' various online communities and social networks, expanding the Smithsonian's impact and presence in the digital world.

### **Executive Summary**

The Smithsonian Institution is the world's largest museum and research complex, with vast collections and expertise in history, science, the arts and culture. Its expanding digital presence represents its commitment to broadening access to people everywhere. Focusing on digital outreach to educators and students, the Smithsonian Center for Education and Museum Studies (SCEMS) launched www.smithsonianeducation.org, whose main feature is an indexed collection of learning resources that are aligned to all state, national, and now, Common Core standards of learning. The site's 2,000 recordcollection of resources such as lesson plans, video and audio clips, and interactive instructional games is one of several Smithsonian finding tools such as its Collections Search Center (7.89 million catalogue records, 779,100 images). Other Smithsonian websites also offer digital collections and tools in specific subjects and collections; the Center's unique goal among Smithsonian websites is to provide access to all Smithsonian resources that are relevant for classroom learning in the most useful ways. The impetus for the *Digital Learning Resources Project* was to help the organization better understand educational uses of Smithsonian digital resources and provide a roadmap for future digital development. The specific research objectives focus on educators' ability to identify, analyze, and extract digital content, with the ultimate goal of enabling all users to achieve their own personal learning objectives through the Smithsonian's resources.

### **Project Goals and Design**

The project had three sets of intended outcomes for the short, medium, and longterm. To achieve them, the *Digital Learning Resource Project* was executed through the lens of intended learning outcomes inspired by a competency framework for teacher instructional analysis and development based on the Next Generation Science Standards<sup>3</sup>.

Original short-term outcomes were to increase teachers' skills in:

- *identifying* specific Smithsonian digital learning content
- analyzing specific Smithsonian digital learning content
- *extracting* specific content from Smithsonian digital learning resources

Medium-term outcomes were to increase:

- skills to make strategic use of digital media and visual displays of data to express information and enhance understanding (Common Core State Standards)
- creativity

Long-term outcome is to foster:

• online users who are active creators of digital resources personalized for learning in their own classroom

The work was organized across four phases of engagement, investigation, development and testing. Phases One and Two involved activities with a group of 20

<sup>&</sup>lt;sup>3</sup> See: http://www.nextgenscience.org/

teacher researchers in Northern California, and a review of previously collected data from teachers between 2009 and 2011 by Foresee and user analytics drawn from Brokers of Expertise (BoE), a resource repository containing the SCEMS collection (www.myboe.org). In addition, during these early phases a review of relevant literature and an environmental scan were conducted to further refine goals and research questions. During Phase Three, initial prototypes were developed and tested by a larger group of 69 teachers over a three-week period in the summer of 2012. Phase Four involved the finalizing of the prototypes based on the findings of the testing and documenting a full set of requirements for the eventual build out of the prototype tool set. The complete review of literature, environmental scan and report of findings are available as separate volumes (Volumes I-III) produced for the project. The Technical Requirements Document for the prototype is available in Volume IV.

#### Findings: Phase One and Two

The results of the research in phases one and two yielded results falling into three emergent categories. Findings were in categories of: Search and Visualization Tools; Engaging, Standards-Aligned, Learner-Centered Content; and Specific Tool Suggestions.

### Search and Visualization Tools

The literature suggests that museums need to make resources more findable and to generate assets that are personalized and accessible anytime, anywhere, and on multiple platforms. We found this to be true in our Teacher Research Group. Teachers asked for:

- An option to exclude search results that require signing up for an account or purchasing a commercial product
- Search results with thumbnails, previews, tag clouds, and rating systems that allow them to easily identify what is useful and what is not
- Personalized search hints
- Search capabilities that can be either highly filtered or extremely broad

### Engaging, Standards-aligned, Learner-centered Content

Previous findings suggest that teachers put student interest and engagement at the top of their list and need content that aligns with learning goals and standards. We also found this to be consistent with the Teacher Research Group (TRG). We therefore conclude that when analyzing resources, teachers want content that will:

- Engage students
- Allow for student interaction and adaptation
- Afford accessibility for various learning styles and levels
- Offer coherence with the lesson and multidisciplinary opportunities
- Support problem-based learning goals
- Support standards-based teaching goals
- Convey a virtual museum experience

#### Instructional Tools

Deeper exploration with the TRG answered new questions about how teachers use museum digital content in their classrooms. When extracting resources, teachers want:

- Flexible technologies for a diversity of devices and delivery methods
- Tools to assess learning
- Tools to adjust reading level of text
- Ways for teachers to upload their self-authored components into a saved file, or resources from other sites or collections
- Graphic organizers
- Discussion and question area
- Vocabulary/glossary builders

Despite this consistency, there is some diversity of opinion reflected across these data that should be noted. While the majority of teachers in the Foresee sample and the TRG prefer lesson planning ideas over fully packaged lesson plans, there is still a small percentage (22% in the Foresee sample and 38% in the TRG) who prefer fully curated lesson plans and materials. This indicates a need to continue to offer fully packaged lessons in addition to new tools for teacher-curated lessons.

#### The Prototype

Based on these findings, developers quickly worked together to create a specific web environment with a functional user interface (UI) and a set of search, save, organize, and instructional adaptation tools tied directly to the existing Smithsonian database of digitized assets and metadata profiles. Full access to the prototype is available at: <a href="http://scems.navnorth.com">http://scems.navnorth.com</a>

These results led to changes in each of three categories: Search and Visualization; Authentication, Saving, and Storing; and Instructional Tools.

#### Search and Visualization

A default gallery view exploits the powerful images of the collections with the images themselves commanding the majority of the available viewing area.

- Text takes a more muted or minimized role on the screen (depending on the view chosen).
- The gallery view offers a palette of images in response to the search query.
- The metadata attached to images is visible as a semi-transparent window when the user rolls the cursor over a selected asset in gallery view.
- Users may opt to modify the settings to generate a more traditional, linear view that offers a smaller thumbnail of the asset.

The prototype design incorporates a simple search interface that surfaces content from not only the SCEMS collection, but also from the larger Smithsonian Collections database. Searching can initially be accessed by the use of direct search terms for those users wanting a simple query correlated to their own subject or topic terminology.

- More advanced search and filter features are handled via suggested tag clouds of common terms and filters for resource type, time period, provider (museum), topic and standards, etc.
- The prototype is designed so that it does not abandon either search methodology, but allows the methodologies to work independently or in concert in order to refine and expand results as part of a dependent cycle.
- An intentional process was deployed to provide users with a wealth of resources and returns, and an exchange point for saving, organizing, or editing a resource or resources of value to them.

### Authentication, Saving and Storing

The design and development team opted to offer users these advanced search and discovery features without requiring the users to authenticate via an account to the prototype site.

- Users are provided a simple, one-step process of generating an account to save an educational resource in a general or specific collection.
- Upon login, users can comment on a resource or collection they have created and share it through email, "pin it" to a Pinterest account, or push it out through Facebook or Twitter. They can also annotate a resource by modifying its title and supporting metadata in ways that make it more appropriate for student consumption.
- Essentially, users can create their own localized metadata profile for a given asset that persists within their collection and can be extended to audiences in formats deemed more accessible.

### Instructional Tools

The prototype provides a series of instructional interactive tools for teachers to wrap around a resource they have saved in a given collection they've created.

- Additional web-based resources or external files that the teacher (or student) provides or has generated can be added directly to a Smithsonian asset using the "additional resources" tab.
- Users can connect to an interactive map through Google maps to locate the resource or area of interest.
- Users can create a concept cloud of primary concept or topic terms, or elect to have students submit their own terms to actively generate a class-wide concept cloud as part of their asset analysis.
- Additional tools include a glossary builder, quiz builder, and crossword puzzle builder.
- Users can also access the Common Core State Standards and suggest matches against the resources and activities they developed as part of their collections.

These interactive elements within the prototype were rendered operational or semi-operational for the most part with the exception of a few utilities that could not be engineered for testing. Researchers designed a prototype testing regime that utilized the operational prototypes as well as other tools, to determine further modifications and design iterations.

#### **Findings: Phase Three**

When taken together, the three weeks of teacher workshops enabled the research team to confirm a set of behaviors and critical input across the participant groups. These have implications for toolset development, interface design, and metadata management. When taken further and compared with the literature, what we know about best practices, usage patterns, and our earlier research, we see both concrete steps as well as questions for further exploration.

If we use the lens of the project goals of identifying, analyzing. and extracting content to become more creative in classroom instructional use, we can summarize the prototype testing findings as follows.

#### Search and Visualization (Identification)

Teacher users commonly:

- Search by entering a general search term, then filtering further if needed. Teachers also preferred the gallery view to review their search results. Participants want more intelligence in their searches and results to guide them toward the most valuable resources. This intelligence included auto-complete typing, auto-correct spelling, and similar items for returns that bear few results.
- Use a diversity of locations to find what they need and have little loyalty to one site in particular, although they go to educational sites more frequently than non-educational sites. In seeking collaboration, researchers conclude, they use both educational and non-educational sites equally.
- Use the Facebook Share option that was provided, but the most popular method of sharing was emailing the link to themselves or a colleague.

#### Authentication, Saving and Storing (Analyzing)

Teacher users prefer:

- To save resources that they find useful. They will use whatever means available to do it, even if the site does not provide this function.
- The flexibility to organize and annotate resources according to their own schemas.
- Flexibility in the types of viewing methods available: one for whole-class interaction (where site order is emphasized and only one site is viewed at a time), and one for individual interaction (where student selection is emphasized and all sites are easily accessed).
- The ability to allow students to use the site and its tools as much as the teacher.
- Content that is aligned, or close to aligned, with Common Core State Standards.

#### Instructional Tools (Extracting)

Teacher users:

- Were excited about the use of "interactive" with the resources found in the Smithsonian collection. After exploring the possibilities available in Docs Teach as well as the Prototype, participants expressed an interest in a variety of tools.
- Appreciated the search functionality of the site but want better visibility of the tools, including prompts and explanations for their use.
- Liked being able to upload resources from other sources to augment their collections and appreciated being given tools that make this easier to accomplish within the site.
- Were looking for more intuitive design and flow between tools and facets of the prototype.

### **Results: Phase 4**

The final phase of the *Digital Learning Resources Project* was to synthesize the findings into a concrete set of technical requirements geared toward the eventual buildout and implementation of the prototype tools. A detailed technical development and implementation plan has been drafted and is available in Volume IV. The general themes of this plan are shared, followed by recommendations for further study and planning.

### **Technical Development and Implementation Plan**

Successfully deploying such a large-scale project does not only depend on system development and technical expertise, but also requires an understanding of preestablished communities and content that the project will replace or be integrated into, the political environment of the organization it will live in, time and budget constraints, expectations of end-users and external evaluators, and the continued life of the system after initial development concludes. Recognizing that this *system* lives within other systems and communities is important to development decisions at project inception. A detailed technical development and implementation plan has been drafted and is available in Volume IV. The following steps are recommended:

- 1. Using existing tools along with additional content authoring enhancements, existing SCEMS content can be regenerated and deployed in the Learning Gallery format as structured and conceptualized in the prototype. This treatment will provide the lead team valuable experience, which will serve as a model for potential support of other units and their content in the same manner.
- Using data from the Phase 3 participating teacher-subjects, identify five key instructional interactives as the lead focus for initial development along with 5 10 others as solicited from Advisory Team members or other SI units as a means to leverage their interest and early participation.
- 3. Having a structured development schedule with verifiable milestones will help to ensure that all project goals are reached efficiently.

#### **Integration with External Services**

For the near term, the majority of users will still be accessing Smithsonian digital learning resources through the SCEMS website, using standard desktop web browsers. Current technology trends are moving users away from these traditional methods, with mobile applications and integrated systems of shared data becoming the norm. Developing on a platform that values data portability and a separation of services from traditional web display will ensure greater flexibility and long-term success for these resources. Examples of ways the SCEMS system can benefit from employing these design methodologies include consideration of the following external services:

- Learning Resource Metadata Initiative (LRMI)
- Learning Registry (LR)
- Pan-Institutional Integration
- Application Programming Interfaces (API)

### Further Study and Planning

Despite the clarity such projects bring, there is always much more to be answered and addressed. Several important planning and policy issues that emerged during the process and were offered as recommendations in the more detailed volumes are reiterated here. Others are offered upon reflecting on the process and the opportunities presented by the completed prototype. Areas for further study and planning recommendations include:

- A new examination of the student user as a growing audience for digital museum resources
- Further examination of the implications of teacher or user authorship and adaption of Smithsonian digital content
- Continued examination of licensing (IP) options and accountability issues as content is shared more broadly in a variety of contexts
- A strategic approach to partnerships and data-sharing
- A focused mobile and media strategy in light of new findings

SCEMS is again to be commended for embarking on this ambitious but important agenda and for designing a process that reflects a new era of teachers and learners. It is, no doubt, an ever-evolving journey, but one well worth pursuing.

#### **Digital Learning Resources Project Final Report**

#### Introduction

This report is the final volume in a series of reports describing the outcomes of the *Digital Learning Resources Project*, a four-phase research and evaluation project of the Smithsonian Center for Education Museum Studies (SCEMS), which informed the design and final specifications for the SCEMS next generation prototype. The purpose of this report is to share the insights gained from both the evaluation process and prototype design and offer lessons learned to other museums pursuing similar questions.

#### Background

The Internet and web together have sparked a revolution in our society and have struck the education community with particular force. The current funding crisis in education, combined with rapid advances in technology – in communications and content sharing – are challenging our relationships with information and learning and positioning us on the threshold of a new era (Kratz & Merritt, 2011). What has happened for formal education and schooling is also affecting museums. The authors of the Smithsonian Institution's Strategic Plan also described us as "on the verge of a new era" where knowledge is expanding faster than we can calculate, and long-held authoritative sources are competing for the attention of our teachers and students against what is most immediate and accessible.

We ...live in a time when technology is changing before our eyes. Delivery channels that seemed like science fiction a decade ago now live on every desktop. Think about the potential for the Smithsonian, holder of remarkable and scientifically important objects and home to world-class expertise, to expand knowledge and add meaning to our world. - Inspiring Generations Through Knowledge and Discovery: Smithsonian Institution Strategic Plan; Fiscal Years 2010-2015, p. 2

The potential is a powerful one, but one that is easily lost if we are not attuned to the ever-changing world around us, and in the case of K-12 education, if we are not attuned to the realities of our nation's teachers and students. The open question is how museums will adapt to and remain relevant in the digital age with search, social, mobile components and instructional tools for learning.

#### **Digital Learning Resources Project Goals and Design**

The Smithsonian Institution is the world's largest museum and research complex, with vast collections and expertise in history, science, the arts and culture. Its expanding digital presence represents its commitment to broadening access to people everywhere. Focusing on digital outreach to educators and students, the Smithsonian Center for Education and Museum Studies (SCEMS) launched <u>www.smithsonianeducation.org</u>, whose main feature is an indexed collection of learning resources that are aligned to all state, national, and now, Common Core standards of learning. The site's 2,000 record-

collection of resources such as lesson plans, video and audio clips, and interactive instructional games is one of several Smithsonian finding tools such as its Collections Search Center (7.89 million catalogue records, 779,100 images). Other Smithsonian websites also offer digital collections and tools in specific subjects and collections; the Center's unique goal among Smithsonian websites is to provide access to all Smithsonian resources that are relevant to classroom learning in the most useful and relevant ways. The impetus for the *Digital Learning Resources Project* was to help the organization better understand educational uses of Smithsonian digital resources and provide a roadmap for future digital development. The specific research objectives focus on educators' ability to identify, analyze, and extract digital content, with the ultimate goal of enabling all users to achieve their own personal learning objectives through the Smithsonian's resources.

#### **Project Goals**

The project had three sets of goals for the short, medium, and long-term. In the short term, teachers would be able to more effectively identify, analyze and extract specific Smithsonian digital learning content. In the medium term, if the project is successful, teachers will increase their skills in making strategic use of digital media and visual displays of data to express information and enhance understanding as well as increase the creativity of their teaching. Ultimately, SCEMS would like to see online users become active creators and sharers of digital resources personalized for learning in their own classrooms. The logic model below (Figure 1) illustrates the outcomes framework for the project.



Program: Digital Learning Resources for and by 21<sup>st</sup>-Century Educators Logic Model

Figure 1. Project Logic Model

### **Project Design**

The *Digital Learning Resources Project* (DLRP) was developed, documented, and shared publicly on a wiki <u>http://smithsonian-digital-learning.wikispaces.com/</u>. The purpose of the wiki is to involve internal and external stakeholders, experts, and educators everywhere in the development of this project; to provide a transparent, fast, and durable medium for project development and refinement; and to demonstrate the potential of an open, public process.

The project was organized across four phases of engagement, investigation, development and testing (see Figure 2). The prototypes were also based on findings from previously collected data from teachers between 2009 and 2011 by Foresee and user analytics drawn from Brokers of Expertise (BoE), a resource repository containing the SCEMS collection (www.myboe.org). In addition, a review of relevant literature and an environmental scan were conducted to further refine goals and research questions. The complete review of literature, environmental scan, and report of findings are available as separate volumes (Volumes 1-III) produced for the project. A "Technical Requirements Document" for the prototype is available in Volume IV.

Figure 2. Four-Phase Project Design

	DLRP Activities				
Phase 1	• Engagement of 20 Northern California teachers to form the Teacher				
	Research Group (TRG)				
Phase 2	Review of previous research				
	Review of user analytics				
	Review of literature				
	Two-tiered teacher research group investigation				
	<ul> <li>Development of initial prototype tools</li> </ul>				
Phase 3	• Test prototypes with 69 teachers in Washington, D.C.				
	Finalize prototype				
Phase 4	Create development and implementation plan				
	Produce technical requirements				

### Phases 1 and 2: Teacher Engagement and Inquiry

The first two phases of the project involved the identification and engagement of a small (n=20) teacher research group (TRG) in California in the spring of 2012, a review of previous SCEMS research, a review of the literature, and an environmental scan.

The identification of this teacher sample occurred through established online education communities included within the Brokers of Expertise or BoE (<u>www.myboe.org</u>) network, utilizing relationships with the BoE partner team, which represents California educators who are currently using Smithsonian Education resources. BoE is an open educational resource repository and online community space for California educators. The SCEMS collection of over 2,000 resources has been accessible through this portal since 2010.

A diversity of educators by grade level and subject area, including those serving a variety of student populations, was a cross-factor considered when selecting teachers based on their capacity to support the prototype development. Twenty teachers were ultimately selected to become part of the "Teacher Research Group" (TRG). Teachers were offered a small stipend for their participation as well as the chance to attend (all expenses paid) the Pearson Summer Institute in Washington, D.C.

TRG members engaged in a two-tier iterative cycle of inquiry, use, and evaluation that involved participating in a series of common "use regimens" as coordinated inperson and via an online community group supported by the Brokers of Expertise system. One central research question framed the observations of researchers:

How did educators find, analyze, modify, or organize the resource(s) for classroom use or electronic distribution to students? Given options:

- a) How do educators prefer to search for resources?
- b) How do educators prefer to save a quality resource they've identified (options on the site, browser bookmarks, copying to local files, etc.)?

- c) Did educators elect to add annotative data to a resource when utilities were provided?
- d) Did educators find and share resource(s) with others through on-site (push to FB, Tweet, etc.) or off-site means (copy URL into email and send to others, etc.)?

The second level of investigation within Phase 2, done independently, called for teachers to integrate two items from the Tier One query into a proposed teaching/learning activity guide, lesson plan, project description, etc., which could be deployed within the timeframe of the regimen period. All instructional plans developed by participating teachers were posted and organized with the respective resource(s) that were utilized for analysis. This was meant to surface issues of findability of resources, teacher preferences, and teacher habits when constructing a lesson with digital resources in general and Smithsonian resources specifically.

This process served to focus the teachers' attention on the practice of using Smithsonian digital resources in the context of identified standards, anticipated student outcomes and objectives, classroom activities, and appropriate assessments in a virtual "fishbowl." Through the process of creating an activity or lesson using a simple upload process, or documentation space located within the online collaborative group tool, or in some instances more adept prototyped curriculum development tools afforded to a small control group trained in its use, teachers engaged both tiers, as described above, to investigate resource elements and develop a structure around them, using a process that is based on ease of use and personal facility to document and share.

Data were collected throughout the development process by using online forum postings and interviews. Additionally, researchers used Bomgar point-to-point software as well as videotaping to physically observe the search and discovery process of Tier One for all teacher subjects.

#### Phase Three and Four: Prototype Development, Testing and Finalization

The final two phases consisted of the development of the initial prototypes based on findings from Phase 2, and the testing and finalization of those prototypes.

The prototype testing occurred over a 3-week period with three separate groups of 20-25 teachers convened in Washington, D.C., for Pearson's Summer Institute, *Mission Possible*. The DLRP prototype testing regimens were designed to address a two-round iteration to the teacher teams: introduce/use/reflect/analyze/synthesize/revise/re-introduce. This cycle was applied to the teachers' ability to perform micro-tasks affiliated with smaller prototyped components as connected to discovery, annotation, enumerative analysis, and promotion in days 1-2, then pedagogical development and publishing in days 3-4, then a final round of generative use/reflect/analyze on the fifth and final day of the combined, comprehensive prototypes.

Each week there were three full iterations of a development and deployment methodology utilizing the accelerated delivery of Agile software development. Educators were familiarized with the project's overall objectives and the specific set of activities and processes they would participate in during the week to help inform the prototype development. Each day, starting with week one, participating educators were given small, timed tasks that related to microelements of the prototype. These microelements focused on searching and discovery, display of various data, selecting, saving and organizing resulting returns, modifying for instructional delivery, and sharing of work. Participants engaged in these tasks with the entire project team observing how they interacted with the various elements.

With each cycle, the development team worked to rapidly integrate these new ideas into the prototype, with clear programming and design tasks to be accomplished within 24 hours for re-delivery to the teacher teams the next morning. The end of each week concluded with a timed exposure to a compilation of the micro-prototype elements as part of the more comprehensive full prototype solution with included revisions from feedback generated throughout the week.

The final week of Phase 3 followed the same structure as above, but focused on a fusion of development with the prototypes from the working analysis and development from the preceding two weeks.

Phase 4 culminated in the compilation of the proposed technical specification to build out the toolset as a functional blueprint for any and all viable agencies considering executing the work (available in Volume IV).

#### **Findings: Phase One and Two**

As noted above, Phases 1 and 2 involved an examination of the user analytics, previous research, a review of the literature (detailed in Volume I), and an environmental scan (Volume II) to provide grounds for the teacher research. The review of literature offered a clear consensus about the type of navigational features and digital assets teachers were seeking, the flexibility required for using those assets in the classroom, and what trends to look for. The environmental scan was then conducted with the aim of investigating who, if anyone, was offering those experiences and assets. What sites are offering the findability, appropriate filters, and high-quality tools for adapting, annotating, saving, and sharing these resources? How does smithsonianeducation.org measure up against these sites, both in the museum world and the general education field? What opportunities exist for SCEMS to fill existing gaps in this arena and become a leader in the field of digital learning resources?

#### **Previous Research**

Previous research and data made available to SCEMS regarding user opinion and usage were an important starting point for the *Digital Learning Resources Project* (DLRP). Evaluations of smithsonianeducation.org over the last nine years had delivered a variety of perspectives on the effectiveness of the SCEMS site in growing a user base in the education community and increasing the exposure of Smithsonian's digital learning assets. A review of the site's general analytics shows a fairly limited number of page views per visit beyond an initial entry. This can be interpreted in any number of ways. It could mean that users are finding what they need, quickly assessing its value, and extracting it for classroom use, or it could mean that users are not finding what they need and going elsewhere. The ability to capture paradata or metadata on how resources are used by teachers visiting the SCEMS site, along with targeted usability research with teachers, is necessary for gaining a fuller picture of what is needed.

Teachers in an earlier Foresee survey sample indicated that they do seek fully developed lesson plans on museum sites (22%) as well as supplemental materials to their own lesson plans (28%). Additionally, the Teachers' Night research told us more about what happens to those materials once they are extracted from the site. Discussions with those teachers revealed the extent to which materials are taken apart, adjusted, and modified to meet to needs of individual schools, classrooms, and students. In other words, "tweaks" were made to fit curriculum goals and to fit the learning levels and styles of students in particular classrooms or groups. It was this finding that catalyzed the SCEMS team initially to look towards the development of more flexible digital tool sets to accompany Smithsonian assets.

These previous findings intersect in multiple ways with the literature on digital learning and museums. Teachers prefer resources that are engaging for students and can be used interactively rather than passively. They seek high-quality images to form the foundation of standards-aligned, cross-disciplinary resources and tools and they want to be able to find and store them easily. But exactly what type of interface and toolset development is needed to meet these needs? These issues are further explored within the DLRP design.

#### Literature and Lessons from the Field

The review of literature and environmental scan, when taken together, offered valuable insights and frameworks for consideration as the DLRP designed investigations with teacher researchers, prototype design, user testing, policy, and planning. It also raised important questions for further study. The conclusions and recommendations fell within four categories: 1) optimizing the search engine, interface, and metadata structure to provide more fruitful search results for a teacher and student audience; 2) expanding partnerships and data sharing; 3) teacher needs; and 4) reviewing instructional tools and web trends and devices.

#### **Optimizing Search and Metadata**

Re-examining museum web content and improving navigational features to optimize searching does not need to be a costly enterprise, but should be done with both internal and external audience needs in mind (Masri & Grossman, 2009). Website users today are searching the web by taxonomy more than ever before and often entering through a Google search rather than a more intentionally developed "front door" website search. Creating taxonomies to organize content dynamically is becoming more common and simple tools for content tagging and display such as Drupal's (CCK) module have entered the marketplace to make the process more automated. Masri and Grossman describe two types of users to keep in mind when reorganizing website content: hunters and wanderers – those who enter a site to find and retrieve what they want quickly, and those who like to explore. Masri and Grossman suggest web designers would do well to "Provide your hunters with distinct navigational links, but give your wanderers items of interest to pursue." (p. 2). Audience studies with both internal and external audiences are an essential ingredient and can be accomplished with small groups and low-tech exercises such as card-sorting to display viewing preferences or surveys.

Older studies evaluating museum sites (Marty & Twidale, 2004) found that "too much content can frustrate users, making them less willing to spend time with the website." Also, having too many choices, they found, could cause users to "make choices without understanding the consequences" or "focus on one area at the expense of others" (Marty & Twidale, 2004, p.5). The same was true for the artistic design and graphical interfaces of their sample sites. They found examples of artistic design that were more distracting and disorienting than helpful, and graphical interfaces that were difficult to navigate. Finally, Marty and Twidale found that exploratory interfaces proved confounding for users who were looking for something specific, but these same interfaces were more geared towards the user who wanted to take the time to explore the collection at a leisurely pace. Sites intended to encourage exploration can, if poorly designed, result in bad searches or "dead ends" discouraging repeat visits.

When organized for an educator audience, the challenge becomes even greater as content must be organized based on established hierarchies and filters for grade level, standard, subject area, etc. Simultaneously, keywords for objects within a museum collection are more ambiguous, causing what some have termed a "semantic gap" and leading to unsuccessful searches.

Most museums have what Google would kill for: semantic knowledge of their collection. We know who made the object, when, and where, and what it is made of. Limiting users to a simple keyword search denies these organizational concepts that can reveal our collections in their fullness. (Solas, 2010, p. 13)

This means that educators searching through museum websites or digital collections databases may be thwarted in their efforts to find what they are looking for if museum sites are not linking their semantic knowledge of objects to a common tagging system and taxonomy more commonly understood by their audience. The extent to which this is happening with the smithsonianeducation.org site should be further explored.

Smithsonian Education and a few other large digital collection sites are doing this well. The following sights offer deep collections of their own or aggregated collections from multiple partners—or both. This type of depth, when designed with intuitive interface as these sites are, provides the user with more high-yield searches.

#### Europeana

<u>The Europeana Foundation</u> is based in the Netherlands and combines the collections of individual libraries, audiovisual collections, archives, and museums

across Europe. It is fairly easy to navigate, and is primarily meant to be interpreted by a user for the students, but could be used as a resource for students compiling content. It includes primary source materials, and allows users to create profiles and customize pages for the storage of content of interest. Also available are tags to sort the resources and a community space for discussion are also available.

#### **Internet Archive**

<u>The Internet Archive</u> is a somewhat cluttered site, but offers a deep collection of primary documents, audio, video, and other materials from a large variety of sources, uploaded by program-savvy users. The images are clear, and the user is able to preview images or resources before accessing them,. While there is a vast amount of content, the navigability of the site is compromised by the layout of the resources.

### **National Gallery of Art: NGA Images**

<u>NGA Images</u> provides public access and again, is primarily meant to be interpreted by the teacher for the student. Primary source materials (artworks) are available and users can create "lightboxes" to store images they find interesting or useful. This gallery view is convenient for previewing images.

#### **Smithsonian Institution Collections**

The Smithsonian Institution Collections Search Center allows access to many different databases, archive collections, library catalogs, and museum collections in an easy-to-search platform. Again, this site seems more designed with a teacher, researcher or mature user in mind. The search capacity is extensive; results can be filtered by grade, subject area, or resource type. Key terms are automatically generated below a general keyword search. Users can create profiles and customize pages for the storage of content of interest.

Both the Europeana Foundation and the Smithsonian Institution Collections allow users to add tags to sort and differentiate resources in a way that makes logical sense to their users. The Internet Archive allows users to write a review of the resource, but tagging wasn't an option. All three sites allowed the user to filter findings by resource type, which can be useful when trying to find an audio recording or video to integrate into a lesson. Users can create profiles for the storage and creation of lists for content of interest on both the Europeana Foundation and the SI Collections site. These profiles allowed the user to connect and group resources according to their own logic. On the Internet Archive site, users actually create a profile through which they upload content themselves. In order to do so, however, one must have knowledge of basic programming and file transfer protocol steps.

Studies on findability and interface design in large digital museum collections indicate the need to examine the extent to which the interface, tagging, and filters, as designed within the smithsonianeducation.org site architecture, are providing optimal searches for their intended audience. The site should demonstrate the following functionalities:

- Offer simplified searches and increase returns that include a comprehensive listing of assets from all digital Smithsonian repositories through the larger Collections Search Center, where possible.
- Provide filters that reflect a teacher's perspective and show those results with others.results that allow for dynamic filtering.
- Employ folksonomies to increase user engagement as well as searchability. Should be given visibility in addition to centrally determined taxonomies.
- Improve initial metadata while browsing/analyzing resources as coordinated with flexible view options when reviewing returned lists, include more visual representations of the resources, include relevant file format information, resource types.
- Provide learners and educators increased means to select, assemble, save, and organize items for extended use and investigation.

### Expanding Partnerships and Data Sharing

Sharing open educational resources and building communities of learning are central components of 21<sup>st</sup> century learning and are being supported by both policy and infrastructure changes at the federal level with the creation of the Learning Registry and the Common Core State Standards (SRI International, 2012). Ensuring broader exposure for SCEMS resources as well as the larger Smithsonian collections database will require increased efforts to form strategic partnerships and share data within these infrastructures and others (Masri & Grossman, 2009; Miller & Wood, 2010; SRI International, 2012). In addition to providing broader exposure of branding and content on the web, these new infrastructures feed back to their parent sites valuable paradata, which enables the site's host to more effectively monitor and evaluate the impact of their digital assets on the education communities they serve.

The concept of sharing machine-readable metadata across large web-enabled repositories originated with initiatives such as Dublin Core (1995) and the more recent W3C Resource Description Framework (1999) specification. The overarching goal has been to provide meaningful descriptions of web resources that are both human readable (semantic) and machine readable (computable). Early efforts to organize learning resources within like data structures began as early as 2002 with the IEEE's, Learning Object Metadata (LOM) Initiative<sup>4</sup>, followed more recently by the National Digital Information Infrastructure and Preservation Program (NDIIPP) of the Library of Congress called "Recollection" in 2010 (Barker, 2005; Miller & Wood, 2010). In order to enable the sharing of metadata within and across domains, such as books and music, initiatives such as Schema.org were developed to standardize domain targeted metadata vocabularies. Specific to educational resource identification and tagging, the Learning Resource Metadata Initiative (LRMI) co-led by the Association of Educational Publishers and Creative Commons has devised and released a unifying metadata framework for

<sup>&</sup>lt;sup>4</sup> See: ltsc.ieee.org/wg12/20020612-Final-LOM-Draft.html

tagging learning resources to better expose agreed upon descriptive fields such as subject area, grade level, instructional object type, and learning standards (Common Core State Standards).

In 2010, the U.S Department of Education released its Education Technology Plan, Transforming American Education: Learning Powered by Technology (see "For Further Reading"), which outlined a vision and strategy for investment and support of education technologies across the K-16 schooling system. Among their series of recommendations was the expansion of student access to open educational resources through shared technology infrastructures. The report suggested to "Create a learning" registry, an open-standard registry of all content developed by various agencies throughout the federal government so that states, districts, and schools can access and leverage it and combine it with their own repositories of content."(p. 21) Just one year later, The Learning Registry was launched as a joint venture between the Department of Education and the Department of Defense. The Learning Resource Metadata Initiative (LRMI), a joint venture of the Association of Education Publishers and Creative Commons and funded by the Bill and Melinda Gates Foundation and the William and Flora Hewlett Foundation, was launched in tandem to support the Learning Registry by developing the necessary system for metadata tagging similar to Schema.org. OER repositories and state-sponsored websites that wish to expose their standards-aligned content to others on the web now have a mechanism to do so. SCEMS was an early partner in the LRMI project, along with the National Archives, the National Science Digital Library and the Library of Congress. In addition to the Learning Registry, the Gates and Carnegie Foundations began work on another infrastructure initiative called the Shared Learning Infrastructure (SLI) in 2011 that is currently being piloted in five states (NY, CO, IL, MA and NC). This infrastructure is designed to work within states to connect disparate student learning metadata into personalized "Learning Maps" for each child, aligned to the Common Core State Standards<sup>5</sup>. The Council for Chief State School Officers (CCSSO) is administering the pilot.

The benefits to Smithsonian and any museum of sharing metadata within these distributed metadata collaboratives are two-fold. Not only will more Smithsonian content surface within other repositories, but analytics on how those resources were used and annotated (which were viewed the most, favorited, commented on, shared, etc.) can be extracted and fed back to SCEMS for evaluation. The first such user analytics were supplied to SCEMS through the Learning Registry as part of the DLRP and are being incorporated into the research findings.

In addition to the benefits of shared metadata, there are distinct benefits to partnering with community sites and content repository managers through APIs, data feeds and simple licensing terms of use for content. Sites such as Curriki, Connexions, Knewton, HippoCampus and Khan Academy offer wide exposure in the education community and social networks for sharing that further promote the exposure of

<sup>&</sup>lt;sup>5</sup> See presentation at: http://siia.net/index.php?option=com\_content&view=article&id=844:siiawebcast-ccssogatescarnegie-shared-learning-infrastructure-summary-aimplications&catid=27:education-overview&Itemid=898

resources. Partnerships will happen in fairly ubiquitous ways, as resource developers and publishers apply common tagging conventions in their markup language through efforts like LRMI, Charlene Gaynor points out in her article *Metadata - The Big Data of the Educational Resource Community* (2012) the inevitable pooling of information and resources that will occur whether through intentional partnerships or not.

Ultimately, LRMI will provide a framework within which a massive array of educational content, ranging from books to videos to lesson plans, can be cataloged, filtered, and delivered. Both commercially published and Open Educational Resource materials will be represented, ensuring that those seeking learning resources will have access to the widest possible range of materials.<sup>6</sup>

And in fact, it is through intentional consideration that many such agencies have elected to participate in early adoption and implementation of these efforts such as Adaptive Curriculum, BetterLesson, CK-12, Houghton Mifflin Harcourt, Learning.com, LearningStation, McGraw-Hill, National Science Teachers Association, PCI Education, Pearson, and Rosen Publishing. By electing to carefully craft and release similar metadata with direct URL feed back to the originating resources, Smithsonian can draw diverse users from a variety of "partner" locations and present them with not only the original resources desired, but also exemplary instructional customization and organization tools for extended engagement and use.

Government and philanthropic efforts to provide mechanisms for data sharing across large repositories of digital learning resources and community sites for content sharing indicate a growing need for respected and authoritative content providers such as Smithsonian to join more fully across multiple partnerships and data structures. This type of activity could prove beneficial to SCEMS and the larger Smithsonian Institution. Further work and study should be prioritized in order to:

- Define business models or benefits to Smithsonian for sharing with particular partners.
- Develop list of potential partners.
- Implement LRMI 1.0 tagging and markup conventions.
- Create outreach strategy and metrics to monitor success.
- Provide single-point, curated metadata to partners in multiple, machine-readable formats.
- Continue Smithsonian publication data in Learning Registry framework.

Teacher Needs

<sup>&</sup>lt;sup>6</sup> See: The Association of Educational Publishers (AEP). Friday, August 24, 2012 <u>http://www.ednetinsight.com/news-alerts/voice-from-the-industry/metadata---the-big-data-of-the-</u> <u>educational-resource-community.html</u>

In the last five years, useum research both in the U.S. and abroad has revealed that teachers seek lesson plans and ideas that are related to concepts or big ideas, closely linked to both state and national standards, are interdisciplinary, do not require a museum visit, and have educational value. They are looking for museum sites that offer simple designs and language and easy-to-search databases, as well as materials that are easy to download and free from copyright issues (Buffington, 2007; Kelly & Breault, 2007). Museum studies suggest that providing teachers with outlines, teaching ideas, suggestions, and Internet links is more valuable than trying to design a "one-size fits all" lesson plan. These studies also show that most teachers do not use lesson plans in their entirety. Instead, teachers tend to pick and choose the parts of the lesson plan that they like and find most useful (Horwitz & Intemann, 2007; Leftwich & Bazeley, 2009). Research regarding how teachers analyze the content they find to determine its value and relevance is extremely limited. Available studies have focused on teacher preferences and behaviors rather than the analytic basis for those behaviors.

Once content is successfully extracted from a site, studies show that teachers use museum resources in a variety of ways and need content that can serve them at any point in the learning cycle from preparing a lesson at home, pre-teaching, to delivering it in class, for student individual interaction or group work, and finally for reflection and assessment. Teachers favor the use of high-quality images to form the foundation of lessons that they build. The object itself, just like in a museum, takes center stage. How that object is interpreted begins with how it is annotated on the site, but ends with how the teacher and her students *use* it, analyze it in a given context, and draw important connections (Buffington, 2007; Leftwich & Bazeley, 2009).

These findings suggest that showcasing high-quality images and providing flexible content, tools and suggestions for teachers would be a better investment of time and resources than in the development of more fully designed, less flexible lesson plans. Does this mean that there is no place for the existing collection of high-quality lesson plans on the site? This question, as well as the question of what types of tools teachers would be most likely to use if they had them, are worth further exploration and part of the research planned by the DLRP.

Studies on digital learning in the classroom and use of digital museum resources indicate that teachers need flexibility to create curricular sequences that meet the learning needs of their particular students. One-size-fits-all lesson plans are rarely utilized as presented, but often taken apart, reorganized or augmented by the teacher while building a lesson. User testing and prototype design should explore these findings in greater detail regarding teachers' need for:

- Flexible assets for use in multiple ways with students to engage their interest.
- Tools that maximize the use of high-quality images.
- Tools and suggestions to help adapt resources to diverse learners that aren't overly scripted.
- Content aligned to Common Core State Standards.
- Collecting and saving resources in a dedicated space on the site.

• Preferences for viewing content and search results.

Very few museums are doing this well. Our environmental scan found most museum sites to be geared more to a teacher rather than student audience (general education sites tend to be more student-centered), and even fewer offer adaptable tool sets for lesson creation. The SCEMS site is the only museum site offering both state and Common Core Standards filtering.

The following websites are the notable examples, found by reviewers, of innovative instructional authoring tools and developed lesson plans, designed by other educator-users of the system.

#### The Kennedy Center: ArtsEdge

**ArtsEdge**, :sponsored by the Kennedy Center, provides users with lesson plans, audio stories, video clips and interactive online modules that are aligned to both national and state standards for the arts. The site provides multiple modes of resource discoverability through the pre-grouping of the resources in easily reorganized lists. These are sorted according to grade level, subject area, and can be viewed in a list view as well as thumbnail view. Each lesson plan is very clearly laid out and includes time required, overviews as well as supplemental materials, and built in tools that enable the user to display pieces of the lesson in several different formats. This format allows the user to see the resources and sort them in a specific manner.

#### The National Archives Experience: Docs Teach

**DocsTeach**, maintained by the National Archives and based on activities focused on the United States Constitution, is compelling at first glance. There are templates for lesson building that allow for annotation and personalization from the user. Content is matched to National History Standards and the site offers a Bloom's taxonomy tool to enable teachers to assess the level of rigor in their lessons.

Thousands of primary source documents are ready to print, or use within an educator-designed, interactive student-driven activity. The main structures of the activity are a variety of expository text structures (sequencing/sequential, "weighing the evidence," compare-contrast). Multiple modes of educational resource discoverability are supported through the streamlined and uncluttered site design. Users can create (and save) their own activities, and can also view other educator's activities (with their supplemental notes added in when they created them). This process allows for both the customization of resources for classroom instruction and implementation as well as the opportunity to share instructional modifications and supplements online, with other educators. Some of the lesson plans are designed in-house and available on the home page, and others are curated from other users on the site. Students can complete the assignments online and email the results to the teacher through the site. Hyperlinks are provided on the activity page for teachers to post to a website for their students. Through these processes, this site provides users, their colleagues, and their students with the opportunity to interact with the content through meaningful exchanges. The site promotes advanced online learning exchanges at a level that is not offered by other sites.

Overall, this site possesses a clear layout of resources and is very streamlined with large icons and simple words. It provides a powerful example of how Smithsonian could expand the way its resources are accessed by its users.

#### North Carolina Museum of Art

<u>ArtNC</u> allows the user to build concept maps around works of art. Features enable users to assemble the resources for use within the classroom. These "concept maps" list grades, subjects and concepts, and can be used within a class to specifically teach educator-designed concepts like family, cycles, interdependence, etc. Provided lessons contain assessments, resources, background information, and comments from other users. The user is equipped with tools to interact with the content and is provided with an opportunity for advanced online learning exchange through the comments from other users. Complete lesson plans also list student learning objectives and standards. The Concept Map building platform was particularly appealing to teacher reviewers.

ArtNC was also highlighted as especially helpful to teachers of special education students. *Easy Approaches to Teaching with* Objects offers important differentiation for Special Education Students. Using the concept maps provides a way to build comprehension for a text.

#### Philadelphia Museum of Art: Education

The <u>Philadelphia Museum of Art</u> site provides users with the opportunity to interact with content and promote advanced online learning exchanges through the creation of a "My Museum" profile. This process allows users to put together galleries of their favorite objects from the online collection. Through the customization of their own "tour" and then the sharing of the resources with others, users of this site have the opportunity to share their instructional modifications.

The ability to customize resources for classroom instruction and implementation is present as well. This site also provides tools that are useful to teachers needing to adapt resources for struggling students. Two examples follow: the first, <u>"Looking to Write and Writing to Look"</u> provides teachers with ideas to support literacy development using anchor standards (for PA and NJ) and could be broken down into smaller IEP skill goals. It also provides an assessment rubric. The second resource called, <u>"What do Primary Sources Tell us about Life Styles?"</u> is a lesson plan that offers modifications for different grade levels as well as formative and summative assessment ideas.

#### Tools and Trends

Museum education sites provide high-quality materials that, in the right hands, will catalyze high-quality learning experiences for students. Nonetheless, with the changing views on the delivery and consumption of knowledge in our education system and our world, museums must wrestle with similar paradigm shifts in their relationships to their audiences. Where is the proper place for the authoritative voice? The question for museum educators is whether or not they can serve as collaborators in a partnership where the raw material for learning experiences provided by museums online is openly interpreted and shared by students and teachers in new ways through social media. "Social media have proven to be very effective in engaging audiences, not simply

connecting them, and provide museums with real opportunities to dialog with audiences in new and substantive conversations and learning experiences." (New Media Consortium, 2010, p. 6)

The perception of the role of the museum audience has evolved during the second half of the 20<sup>th</sup> century and the beginning of the 21<sup>st</sup> century in interesting and significant ways (Stylianou-Lambert, 2010). Technology and the Internet are at the center of this disruption. Historically, museums have been viewed as the authoritative voice with messages to convey to passive learners and audiences. Gradually, this paradigm has shifted to a more participatory relationship with museums that Stylianou- Lambert of Cyprus University describes as "Spectacle/Performance Paradigm" of the last decade. This paradigm is characterized by multimedia approaches to audience engagement and interaction with exhibits and the ability for audiences to more freely interpret meaning through their own perspectives and chosen mediums. Most recently, however, a concept of museums as "an open work" is emerging, where the audience acts in partnership with museums to contribute and interpret content that is publicly displayed on museum websites through social media. This movement is not without its critics who are concerned that the academic rigor of professional museum interpretation and curation will be lost in favor of more questionable interpretations for which the museum is still held ultimately responsible. This authority is further challenged by the notion that users may wish to annotate or adapt a museum resource and share it with others.

The trend towards utilizing publicly created content through social media such as Facebook, Twitter, YouTube, Flickr, and others has caught on in the business world with examples such as news media requesting videos from citizens related to news items and toy companies such as Lego inviting Lego Club members to create new kits. In the K-12 education world, teacher-created lesson plans are being shared in multiple ways within community sites and content repositories such as Thinkfinity, Share My Lesson, Curriki, Brokers of Expertise, and Teachers.net (Chao, Parker & Fontana, 2011; Bull et al., 2008). The popularity of these sites tells us that teachers want to share lessons and belong to such communities, but the literature on how teachers specifically take advantage of social media for their teaching is extremely limited to date.

In the museum education world, social media was recognized fairly early as an opportunity to build communities of practice outside of the museum walls and to more fully engage audiences. Early museum attitudes about social media spaces were more about "build it and they will come" without thorough discussion of audience needs and strategic, sustained relationship building (Russo, 2011). Creating more sustained participation in social media spaces, museums need to develop better understandings of the types of cultural exchanges they wish to elicit." This necessitates a better understanding of their audience.

Smithsonian's Cooper-Hewitt National Design Museum is an early example of a museum that effectively built an online community of practice utilizing an alreadyestablished and well-understood audience of teachers. The museum's signature Summer Design Institute (SDI) program was restructured in 2006, after finding that the communities that were fostered during the summer program were too difficult to maintain long-term the museum created the Education Resource Center (ERC).<sup>7</sup> ERC integrates standards-based lesson plans, created by teachers related to design and provides a space for community dialogue. "This has reinforced a community of practice of educators in a trusted environment (the museum) with the potential for the outcomes to inform others and provide new knowledge in museum learning."(Russo et al., 2008, p.27)

Rapid growth in usage of mobile Internet technologies represents the need to focus on learner-centered design of museum content. Mobile technologies in effect put the user in the driver's seat because learning becomes truly personalized and active rather than generalized and passive. With the proliferation of mobile devices, such as smartphones and tablets, users will demand a seamless learning experience from anywhere, such as the classroom, home and museum. Statistics show that mobile media technologies such as tablet/smart phone apps and the mobile web represent the future of Internet access rather than the browser on desktop computers (Meeker, Devitt, & Wu, 2010). While mobile app building can be costly and achieving interoperability of mobile web content is challenging, mobile media technologies are increasingly being utilized to draw attention to specific exhibits and websites. Lessons learned from early examples will provide valuable insights to SCEMS as they consider mobile learning in the future.

Today's students operate in a world that is increasingly connected. They and their parents expect to be able to utilize technology to assist with family communications as well as work and school projects. A 2010 national survey of over 42,000 students and over 35,000 parents on their current technology practices and expectations show emerging trends of e-textbooks, mobile learning and online/blended learning, as having the largest impact on schooling. "These trends include the essential components of the student vision of socially-based, un-tethered and digitally rich learning, but they also directly address the three new "E's of Education" – enable, engage and empower." (Project Tomorrow, 2010, p. 3)

The use of mobile devices by museums has been largely tactical to date. A strategic approach incorporating web, community, and mobile learning into a coherent whole must ultimately be the goal. The lesson offered by recent case studies in Britain and Canada (Kennedy, 2012; Lagoudi & Sexton, 2010) is to be very clear about the target, goals and added value of a mobile app or mobile web for your intended audience before venturing into these types of development projects. Mobile apps can be powerful tools for drawing attention to your website in terms of branding and interactivity, but you must be clear about the "added value" and it is still too early to measure the full impact (in dollars and visitor numbers) of various types of apps being used by museums so far. A broad and well thought out mobile strategy has significantly more promise than a singular move towards mobile app development for increasing the potential, for not only site visits, but for access to structured learning resources.

<sup>&</sup>lt;sup>7</sup> http://www.cooperhewitt.org/tagged/educator-resource-center

Trends in the use of social media and mobile phone and tablet use in schools is expanding and gaining greater acceptance. It is critical, however, that a strategic approach to web, community and mobile learning should be taken before large investments are made. SCEMS should consider the following preliminary steps:

- Incorporate mobile-friendly features in current site content and functionality.
- Mimic iPhone Rolodex or gallery views to assist with later potential mobile device integration.
- Research the extent to which teachers would use social media to contribute content to the site.
- Research the extent to which teachers would share content or participate in online communities.
- Consider integration of emerging trends such as geolocation tools and augmented reality for the K-12 mobile learning audience.
- Examine carefully the specific value-added of any mobile learning application along with costs associated with its on-going management, weighing them against the advantages of mobile web investments.

### **Findings: Teacher Research Group**

The final step of Phase 2 was to engage our Teacher Research Group in a deeper exploration and confirmation of the findings of the literature and best practices. Where these findings showed us *what* teachers were looking for, the deeper exploration helped us understand more about *why* teachers might choose a particular resource over another, and *how* they might use it to build a lesson. The review of best practices showed us who we were competing with for the attention of the educator audience and what was possible. Our Teacher Research Group confirmed these findings and provided more concrete examples of lesson-building, promoting-and-sharing tools that were useful for prototype considerations.

#### Search and Visualization

The literature suggests that museums need to make resources more findable and to generate assets that are personalized and accessible anytime, anywhere and on multiple platforms. We found this to be true in our research group. Teachers asked for:

- An option to exclude search results that require signing up for an account or purchasing a commercial product
- Search results with thumbnails, previews, tag clouds, and rating systems that allow them to easily identify what is useful and what is not
- Personalized search hints
- Search capabilities that can be either highly filtered OR extremely broad to find what they are looking for

#### Engaging, Standards-aligned, Learner-centered Content

Previous findings suggest that teachers put student interest and engagement at the top of their list and need content that aligns with learning goals and standards. We also

found this to be consistent with the TRG. We, therefore, conclude that when analyzing resources, teachers want content that will:

- Engage students
- Allow for student interaction and adaptation
- Afford accessibility for various learning styles and levels
- Offer coherence with the lesson and multi-disciplinary opportunities
- Support problem-based learning goals
- Support standards-based teaching goals
- Discover a virtual museum experience

#### Instructional Tools

Deeper exploration with the TRG answered new questions about how teachers use museum digital content in their classrooms. When extracting resources, teachers want:

- Flexible technologies for a diversity of devices and delivery methods
- Tools to assess learning
- Tools to adjust reading level of text
- Ways for teachers to upload their self-authored components into a saved file, or resources from other sites or collections.
- Graphic organizers
- Discussion and question area
- Vocabulary/glossary builders

Despite this consistency, there is some diversity of opinion reflected across these data that should be noted. While the majority of teachers in the Foresee sample and the TRG prefer lesson planning ideas over fully packaged lesson plans, there is still a small percentage (22% in the Foresee sample and 38% in the TRG) who prefer fully curated lesson plans and materials. This indicates a need to continue to offer fully packaged lessons in addition to new tools for teacher-curated lessons.

#### The Prototype

Determining the specific technical responses to these findings and making decisions on how resulting features and tools would surface as prototypes was the next step in the DLRP process. Interpretation of this research was conducted by a multidisciplinary team of educational technology specialists, digital curriculum development specialists, and educational software/application engineers, and was vetted against the collective experience of the members and the observations and data gathered from the TRG teams over the period of two months. This team determined that the initial prototypes should focus on prescribed methods to enable more comprehensive search results and more metadata. The prototypes should offer enhanced promoting-and-sharing tools to extend user activity beyond the Smithsonian web environment, and tools for adapting and sharing content for the classroom.

#### Search and Visualization Tools

Teachers have moved from focusing on *quantity* of results to *quality* of results. While the relative value of securing many results still remains, teachers are interested in quickly sorting those results through the prescription of filters such as standards, topic directories, and even other teacher feedback. Methods to surface, identify, and aggregate quality resources into more finite collections for further analysis and organization should be easily integrated into the search-and-discovery process. Prototypes should provide a mediated process for searching, discovering, and organizing resources, one that does not fracture the stream of thinking of the consumer and that provides multiple view options based on user preference. Additionally, better relational data made more visible and integrated between items and collections should create a richer return of results for users. Prototypes should integrate some processing of common metadata to assure results that are specific and related, in order to provide a broader range of relevant resources for further filtering at the users' discretion.

#### Authentication, Saving and Storing Tools

Teachers tended to promote the idea of accessing the work, findings, and assertions of other educators, along with the desire to share their own in the online environment. At the same time, features that allowed teachers to document and publish such data are nonexistent or limited, and often tertiary to the process of discovery and aggregation. Therefore, the extra steps it would take to surface this type of information to appropriate audiences caused a barrier to participation. Prototypes should consider an "opt-in" push technology model that allows teachers to easily identify existing social communities and push relevant activity updates across those communities as an integrated component to sharing collections, favorite resources, comments, ratings, etc. Where appropriate, this same data should be surfaced within the resource framework itself to help illuminate use and promote additional sharing.

#### Adapting and Extracting Tools

Teachers find high value in resources that have been designed with considerations for classroom presentation and student interaction. Conversely, many resources have not been given such treatment. It is time-consuming and knowledge-and-expertise intensive for agencies to perform this type of "work-up" on large segments of their collections. Therefore, teachers are increasingly interested in tools that allow them to manipulate and augment existing resources with enhancements such as timelines, graphic organizers, assessments, supplemental materials, and interactives of their own making. It is a professional practice that teachers have engaged in readily "off-line," which has gone largely unidentified and unharnessed. Teachers are growing continuously aware of the technical possibilities found in other online systems that promote user-generated content, supplementary instructional activities, and resource assembly and exchange among users of a given collection. Tools to be developed should integrate means to allow educators to manipulate various content elements and add-on generative instructional activities. Further, educators should then be allowed tools to sequence and share these constructs with students in direct or self-led formats and finally publish the resulting materials to colleagues.

Based on these conclusions, the following instructional interactive elements were designed as part of the initial prototype. The features illustrated below were rendered operational or semi-operational for the most part, with the exception of a few utilities that

could not be engineered for testing. Researchers designed a prototype testing regime that utilized the operational prototypes as well as other tools to determine further modifications and design iterations.

### **Initial Prototype Features**

The prototype design incorporates a simple search interface that surfaced content not only from the SCEMS collection, but also from the larger Smithsonian Collections database. The default visual display represents a compilation of research findings. The images command the majority of the available viewing area, and text takes a more muted or minimized role on the screen (depending on the view chosen). The cascade-style postering of images similar to that of standard image gallery views and capabilities make the pages visually appealing and promote the assets themselves above and beyond the descriptive data for quick assessment by educators for instructional relevance.

Image 1. Prototype Gallery View



The gallery view (displayed above) offers a palette of images in response to the search query. The metadata attached to those images is visible as a semi-transparent modal window when the user rolls the cursor over a selected asset in gallery view (bottom right of image). Searching can initially be accessed by the use of direct search terms for those users wanting a simple query correlated to their own subject or topic terminology. More advanced search-and-filter features are handled via suggested tag clouds of common terms and filters for resource type, time period, provider (museum), topic, standards, etc. The prototype is designed not to abandon either search

methodology, but to allow them to work independently or in concert to both refine and expand results as part of a dependent cycle.

Image 2. Prototype Linear View



Users may opt to modify the settings to generate a more traditional, linear view (above). This view offers more precedent information as a first tier of data, rendering a smaller thumbnail of the actual asset. It is important to note that the design and development team opted to offer users these advanced search and discovery features without requiring them to authenticate via an account to the prototype site. An intentional process was deployed to provide users a wealth of resources and returns to invest them quickly into an exchange point of saving, organizing, or editing a resource of value to them. Users then having an innate desire to cross this threshold are provided a simple, one-step process of generating an account to move a valued instructional asset into a general or specific collection.

In addition to saving valued resources upon login, users can comment on a resource or collection they have created and share it through email, "pin it" to a Pinterest

account, or push it out through Facebook or Twitter and annotate a resource by modifying its title and supporting metadata in ways that make it more appropriate for student consumption. Essentially, users can create their own localized metadata profile for a given asset that persists within their collection and can be extended to learner audiences in formats deemed more accessible.

The prototype provides a series of instructional interactive tools for teachers to wrap around a resource they have saved in a given collection they've created. For example, additional web-based resources or external files that the teacher (or student) provides or has generated can be added directly to a Smithsonian asset using the "additional resources" tab (Image 3).

For the prototype purposed, the designers created a series of sample activity-based interactive tools that users could elect to enable and attach to a given asset in collections they developed. While these are not designed to be an exhaustive set of offerings, they were developed as "functional to semi-functional" to assess where and how teachers might elect to use them and to prompt further suggestions as part of the testing regimen. Of those generated for the prototype, users can connect to an interactive map through Google maps to locate the resource or area of interest. See the Kitty Hawk example in Image 4. Users can create a concept cloud of primary concept or topic terms, or elect to have students submit their own terms to actively generate a class-wide concept cloud as part of their asset analysis (Image 5) Additional tools include a glossary builder, quiz builder, and crossword puzzle builder. Users can also access the Common Core State Standards and suggest matches against the resources and activities they develop as part of their collections.

![](_page_34_Picture_3.jpeg)

Image 3. Additional Resources Tool

### Image 4. Google Map Tool

![](_page_35_Picture_1.jpeg)

Image 5. Concept Cloud Tool

Smithsonian Education (wright brott )	My Collections Sign Out
The Wright Brothers First Flight at Kitty Hawk, No	Original Resource Switch to View Mode Save
	Concept Cloud Type in 3 words of your choice that describe the resource thin eager  Submit  flying hoppy means have brothers pare accomplishment power celebration innovation warvey maximum wright-ont  flying hoppy construction innovation warvey maximum wright-ont

### **Phase 3 Prototype Testing**

Throughout the summer, Council for Chief State School Officers (CCSSO) "State Teachers of the Year" from across the country were in residence for weeklong

explorations of digital learning workshops called *Mission Possible: The Model Classroom*, sponsored by the Pearson Foundation.<sup>8</sup> Participants were largely classroom teachers ranging in grades from K-12. The first two cohorts of teachers represented the Teachers of the Year. The final cohort consisted of state teams and other teachers and administrators nominated by the CCSSO to participate. In addition, five teachers from the California TRG were selected to attend during weeks one, two, and three to provide some continuity across the two phases of teacher research (see Figures 14 and 15 for grade and subject area distribution and states represented).

In three weeklong sessions, SCEMS researchers were given access to these teachers for one hour for four of the five days of the week. The challenge was to design activities that could yield answers to important questions about the primary impetus and drivers affecting teachers' needs and proposed uses of digital resources. SCEMS garnered direct feedback on the utility of the prototype features. There was rapid turnaround and redevelopment each week to address issues raised in the previous week.

### Research Activities

Engineers and researchers elected to begin by directing participating educators to a compilation of paper-based interface activities and existing web resource sites for confirmation of some basic structures in which to create a full prototype. The educational technology and developers quickly worked together to create a specific web environment with a functional user interface (UI) and a set of search-save- organize-adapt tools tied directly to the existing Smithsonian database of digitized assets and metadata profiles. Full access to the prototype is available at: <u>http://scems.navnorth.com.</u> Each of these activities was designed to find answers to a series of guiding research questions:

### Research Question 1: (Applied all 3 Weeks)

How do various related searches, ranging from global to granular, render results within the prototype structure, and how are those results best used by the educators for classroom use?

Research Question 2: (Applied all 3 Weeks)

Once teachers find viable resources for use in the classroom, how do they prefer to display those resources to their students and engage with them?

### Research Question 3: (Applied all 3 Weeks)

How readily can participants assemble their own unique collections and integrate instructional interactives?

### Research Question 4: (Applied ONLY in 3<sup>rd</sup> Week)

If given tools to include Common Core State Standards and external web resources, will teachers feel confident in analyzing and identifying appropriate additional resources and standards as correlated to Smithsonian resources?

<sup>&</sup>lt;sup>8</sup> See: <u>http://www.newlearninginstitute.org/model-classroom-ccsso-teachers-year</u>

Each week presented the research team with a different cohort of teachers and, as mentioned earlier, with each week, modifications were made to the prototype as well as to the activities depending on the grade and subject areas represented, revised goals, or feedback from previous participants. Activities incorporated use of other sites highlighted in the environmental scan as well as tasks with the SCEMS current site and the prototype. In some cases, teachers created posters or worked with paper images to illustrate how they would like to see images displayed and organized. A team of researchers observed each activity and recorded their observations, using an annotation key. Observers were assigned groups of teachers to observe during each activity to ensure consistency and accuracy. A final survey was administered electronically to all participants of both phases of teacher research. Posters and paper exercises were photographed and analyzed by designated researchers and further quantified. Surveys were administered through the Facebook page being utilized by the Summer Institute attendees.

#### Findings: Phase 3

When taken together, the three weeks of teacher workshops enabled the research team to confirm a set of behaviors and critical input across the participant groups that have implications for toolset development, interface design, and metadata management. When compared with the literature—as well as our earlier teacher research and what we know about best practices and usage patterns-- the experience points to concrete steps as well as questions for further exploration.

If we use the lens of the project goal of teachers identifying, analyzing, and extracting content to become more creative in the classroom, we can summarize the prototype testing findings as follows.

When searching for or identifying content:

- Teachers prefer to search by entering a general search term, then filtering further if needed. Teachers also preferred the gallery view to review their search results. Participants want more intelligence in their searches-and more results—to guide them toward the most valuable resources. This intelligence includes auto-complete typing, and auto-correct spelling.
- When seeking content online, teachers use a diversity of locations to find what they need and have little loyalty to one site in particular, although they go to educational sites more frequently than non-educational sites. In seeking collaboration, researchers conclude, they use both education and non-education sites equally.
- Participants used the Facebook Share option that was provided, but the most popular method of sharing was emailing the link to themselves or a colleague.

When analyzing content, teachers:

• Want to save resources that they find useful. They will use whatever means available to them to do it, even if the site does not provide this function.

- Want the flexibility to organize and annotate resources according to their own schemas.
- Need flexibility in the types of viewing methods available: one for whole-class interaction (in which site order is emphasized and only one site is viewed at a time)and one for individual interaction (in which student selection is emphasized and all sites are easily accessed).
- Would like the ability to have students use the site and its tools as much as the teacher.
- Utilize curriculum that is aligned, or close to aligned, with Common Core Standards.

When extracting content to create an interactive lesson, teachers:

- Were excited about the "interactives" that complement the resources found in the Smithsonian collection. After exploring the possibilities available in Docs Teach as well as the Prototype, participants expressed an interest in a variety of tools.
- Appreciated the search functionality of the site but want better visibility of the tools, including prompts and explanations for their use.
- Liked being able to upload resources from other sources to augment their collections and appreciate being given tools that make this easier to accomplish within the site.
- Looked for more intuitive design and flow between tools and facets of the prototype.

### **Finalizing Requirements**

Ultimately these findings were applied to the finalization of the prototype to complete the iterative evaluation cycle. A synopsis of the guiding research questions applied to the project goals framework and the resulting prototype features and functions are itemized below in Figure 4. Technical requirement specifications for these features are presented in DLRP's Volume IV, *Technical Specifications Document*.

I/A/E	Modification Suggestions for Next	Increase	Increase	Active
Elements↓	Round of Testing	Skills	Creativity	Creators
Identifying	Week 1			
$\downarrow$	Provide more comprehensive metadata	Х		
	associated with digital items/assets where			
	that metadata exists			
	Mimic or mock-up a more comprehensive	Х		
	front end for users initiating a search to			
	avoid confusion about the use of a			
	partially developed prototype			
	Create prompts for yet-to-be developed	Х		
	items that indicate upcoming features			
	and/or prompt users for feedback			

Figure 4. Cumulative Prototype Modifications

I/A/E	Modification Suggestions for Next	Increase	Increase	Active
Elements↓	Round of Testing	Skills	Creativity	Creators
	Consolidate actionable terms like Curate	Х		
	(modify to be more clear on related			
	process associated with this term, like			
	Save) functions like Save and Go Back,			
	add to collection, create collection and			
	"flatten" transition process for selecting			
	items and moving into collection without			
	expanded view modal screen possibly or			
	collapsing collection item view with			
	expanded modal view.			
	Week 2		•	
	Use more common teacher terminology	Х		
	and student-centered language in			
	description of items and tools			
	Create a list of existing search terms	Х		
	correlated to teacher-centered subject lists			
	for accessing resources.			
	Consolidate all Smithsonian assets from	Х		
	various units/collections behind a single			
	point of entry and set of search tools.			
	Clear filters upon new search	Х		
	Week 3		•	
	Create directories of resources as tied to	Х		
	Common Core Standards.			
	Create directories of resources developed	Х		
	by other educators.			
	Create subdirectories or subordinate	Х		
	descriptors based on rigor and relevance			
	levels.			
Analyzing↓	Week 1			
	Provide clear entry point and	Х		
	corresponding terminology for the			
	instructional modification options related			
	to a given resource item within a			
	collection.			
	Create more semi-functional instructional			Х
	modification options for user to try.			
	Show visual of interactive instructional	Х		
	tool to aid teachers in choosing an			
	appropriate activity, in addition to teacher-			
	centered description.			
	Consider proximity of instructional tools to		X	
	the resource item, possibily providing			
	resizing options.			

I/A/E	Modification Suggestions for Next	Increase	Increase	Active
Liements	Wook 2	SKIIIS	Cleativity	Cleators
	Allow too hors to correlate			V
	Allow leachers to correlate			А
	conections/activities to sample question			
	items from end-of-year state assessments			
	skills.			
	Allow teachers to develop resource			X
	considerations in the context of a full			
	lesson plan in order to better frame			
	resource selections and sequence.			
	Week 3	<u> </u>		
	Offer more compare-and-contrast tools			X
	and better conceptual diagramming			
	features for students to organize			
	information and inferences			
	Interactives provide teachers new			X
	considerations and perspectives to			
	stimulate instructional thinking and			
	approaches when new tools/aids are			
	suggested by system or other teachers.			
Extracting	Week 1	I		
8*	<i>Collections can be saved and retrieved at</i>	X		
	later point with user authentication.			
	<i>Collections can be modified beyond point</i>	Х		
	of original creation.			
	Collections can be shared via traditional	Х		
	means such as email and download.			
	Collections can be shared via digital	Х		
	communities in which a teacher already			
	participates.			
	Collection can be displayed for classroom			Х
	implementation (eventually rearranged per			
	teacher demonstration preferences).			
	Week 2		Γ	
	Push resulting student work/entries on quiz			Х
	interactives to spreadsheet or publish to			
	thirrd-party learner community site like			
	Edmodo.			
	Allow teachers to highlight sections of web			Х
	resource and embed information or			
	question bubbles that students will then			
	encounter upon review of resource.			
	Add chat feature for teacher and students.			
	Offer library of open license audio files in		X	Х

I/A/E Elements	Modification Suggestions for Next Round of Testing	Increase Skills	Increase Creativity	Active Creators
	the way of songs or sound effects that teachers can load as related to content of collection. Students can select which should accompany their own collections as well.	<u>Shins</u>	Cicultity	
	Provide teachers a final "publish" button or check box that allows them to determine when something is ultimately shared or unshared with students.	Х		
	Provide a drawing space for students or teacher to draw responses to resources.			Х
	Include imeline tool that allows a teacher or student to lay out resources and corresponding information on a chronological timeline			Х
	Consider multiple options for student work to transmit to teacher other than just email.	Х		
	Week 3			
	Include method to let teachers "download" ready to use collections with embedded activities, but then "upload" variations and modifications made to those materials.			Х
	Blend the activity/interactive tools into the resources by suggesting certain tools for certain types of resources would expedite the research and application process during lesson planning and design.		Х	

### **Results: Phase 4**

The final Phase of the *Digital Learning Resources Project* was to synthesize the findings into a concrete set of technical requirements geared towards the eventual buildout and implementation of the prototype tools. A detailed technical development and implementation plan has been drafted and is available in Volume IV. The general themes of this plan are shared here, followed by a reflection on the lessons learned and recommendations for further study and planning.

#### **Technical Development and Implementation Plan**

Successfully deploying a large-scale project such as this does not just depend on system development and technical expertise, but also requires an understanding of preestablished communities and content that the project will replace or be integrated into, the political environment of the organization it will live in, time and budget constraints, expectations of end-users and external evaluators, and the continued life of the system after initial development concludes. Recognizing that this system lives within other systems and communities is important to making decisions at project inception. This presents new issues that must be considered as part of any development-andimplementation plan. Initial steps involve the reuse of pre-existing content and the prioritization of interactives, followed by structuring a progressive development schedule.

#### Pre-existing Content

Using resource instructional organization tools with additional content authoring enhancements, existing SCEMS content can be re-generated and deployed in the Learning Gallery format as structured and conceptualized in the prototype. The treatment for processing the existing materials will provide the lead team valuable experience in the regeneration of content that will serve as a service model for potential support of other units and their content in the same manner.

#### Prioritizing Development of Interactives

Using data from the Phase 3 participating teacher-subjects, five key instructional interactives could be the lead focus for initial development along with 5 - 10 others as solicited from Advisory Team members or even other units as a means to leverage their interest and early participation.

#### Structuring a Progressive Development Schedule

From start to completion, having a structured development schedule with verifiable milestones will help to ensure that all project goals are reached efficiently. Though timelines and priorities will change along the way, being able to map the project's overall trajectory and progress aids in maintaining momentum. Details on each phase of the development schedule are outlined in Volume IV.

#### Integration with External Services

For the near term, the majority of users will still be accessing Smithsonian digital learning resources through the SCEMS website, using standard desktop web browsers. Current technology trends are moving users away from these traditional methods, with mobile applications and integrated systems of shared data becoming the norm. Developing on a platform that values data portability and a separation of services from traditional web display will ensure greater flexibility and long-term success for these resources. The following are some of the ways the SCEMS system can benefit from employing these design methodologies to be better positioned for connecting to external services:

#### Learning Resource Metadata Initiative (LRMI)

In order to make it easier for Internet searchers to find what they are looking for, the major search engine companies (Bing, Google, and Yahoo) formed the schema.org initiative in June of 2011. They agreed to recognize a shared markup vocabulary that websites could embed as attributes within their pages, making it easier for seemingly unstructured display data to be machine-processed in a precise manner, better exposing the underlying information for people searching for it. LRMI is a set of attributes created to describe educational resources, and has been submitted to be included as a sub-set of schema.org. The promise of these new methods is that minimal data tagging efforts on a web developer's behalf will expose learning resources and their associated data descriptors (subjects, grades, assessment information, standards alignment, etc.) in a structured manner to search engines and other data processing applications. Additionally, LRMI is being considered as a lightweight metadata schema that could be used to share data between systems, rather than translating metadata into more formally structured schemas like SCORM or Dublin Core.

#### Learning Registry (LR)

In 2011, the Office of Education Technology developed and launched the Learning Registry, an open network for sharing data about learning resources. The system is designed to facilitate the exchange of data describing what resources are available, as well as usage and rating information about the effectiveness of those resources. The majority of the data in the LR falls into two types: 1) metadata, or detailed and structured data describing the resources themselves, in a variety of supported schema, and 2) paradata, or contextualized usage data about the resources, including ratings, favorites, comments, aggregate view and access counts, standards alignment, and connections between resources. The new SCEMS system should setup to publish and consume both types of data, broadcasting information about new and updated learning resources, as well as the ways they are being used by educators. The LR then becomes a valuable dissemination point for other systems to open up access to SCEMS resources, as well as a way of closing the loop with external partners that want to know how their resources are being accessed within the SCEMS system. For instance, when a teacher uses a Smithsonian resource to help teach a concept and aligns it to a common core standard, that alignment information should be shared via the Learning Registry so that other educators could benefit from that usage example when teaching the same standard.

#### Pan-Institutional Integration

The launch of the new SCEMS system will open up an entirely new set of tools for educators to make use of the wealth of resources that the Smithsonian Institution houses. For the benefit of all of the units' education and web departments, easy integration between institutional websites should be a cornerstone of the development. Content developed within these tools can be accessed through multiple methods, allowing collaboration between units, and a better means of consolidating pan-Institutional teacher resources, while also allowing units to maintain online autonomy. Additionally, building the tools on a service infrastructure with portable data will provide for a variety of other display options to be employed in the future, such as kiosk displays to be used within museums or museum educational centers.

#### Application Programming Interfaces (API)

Much of the success of the prototype tools can be attributed to the way they present such a large collection of Smithsonian resources in visual manner. Implementing this functionality on a short timeline was only possible because the Smithsonian had the foresight to build the Enterprise Digital Asset Network (EDAN). Rather than just build a unified search on a single web page, we created an API and made it available to authorized applications for the accessing of this valuable set of data from other tools and systems. Using this model, the new SCEMS system should have a set of services to allow outside services to interact with its functionality and data. The ultimate reason for offering an API is to provide content or services in a flexible way. As the Internet moves towards a variety of devices and interfaces, APIs can provide for the ultimate level of flexibility and control for future technologies, without requiring additional data manipulation and programming in the central system.

#### **Lessons Learned**

*The Smithsonian Digital Learning Resources Project* presented the research team with a rare opportunity to bring educators from across the country together to help explore the critical questions museums are facing in the new digital era. Doing this research in the context of the Smithsonian Institution's vast network and collection enabled researchers to address common issues that face many museums and institutions that store large digital collections. SCEMS particular leadership provided the educational lens which is too often absent from the research and development process of K-12 educational tools. They are to be commended for taking a teacher-centered approach to designing their investigations. The successes, challenges and lessons learned in the *Digital Learning Resources Project*, it is hoped, will guide other organizations seeking similar direction as they consider web and media projects in the coming decade.

#### Successes

A summary of the successful elements of the research design begins with the ability to work within two very different cycles of inquiry. The first, a preliminary exploration with teachers in California, allowed for unguided attempts at tool use prior to supporting them with direct instruction to assess remote, autonomous-use cases. Observing teachers in multiple ways during this process enabled us to view the full cycle of search-identify-analyze-use and brought to the surface valuable case scenarios that will inform prototype development.

Second, once prototype tools were developed, the ability to provide teachers with direct access to the tools was critical. Issues surfaced during activities that provided valuable information to engineers. The information would not otherwise have been available to them had they not been working with real teachers thinking in real terms about their students. Researchers were able to disaggregate components of the prototype to focus teachers on smaller, precise activities under timed conditions. Observers could

then solicit specific feedback on the smaller activities and processes. Ample observers also provided solid checks and crosschecks on data collection and guarded against researcher bias.

#### **Challenges/Limitations**

As in any research endeavor, there are challenges and limitations to be noted. In reflecting on the research design and implementation, researchers noted two areas that presented challenges to the research that were unavoidable,. They fall into two categories: Metadata Management and Prototype Testing Format.

#### Metadata Management

Given the diversity of assets and the number of sponsoring units within the Smithsonian Institution, there are issues of consistency of metadata and management that affected the project but may not affect others in the same way. It is worth noting, however, that image resolutions, specifications, and formats were inconsistent across data sets harvested from the larger Smithsonian Collections. In other words, the metadata that one museum or unit had entered for a given object did not necessarily match another's in format, type, or vocabulary. Also, metadata format for assets did not differentiate between records that contained images and those that did not. This meant that some metadata were more easily interpreted by the non-curator K-12 audience than others. This affected the success rate of searches as well as the analysis by teachers of the appropriateness of the asset.

Consideration should be given to creating supplementary object metadata to create formats/versions more accessible to student audiences based on age/grade levels. This issue is addressed in the "Technical Requirements" document (Volume IV).

#### Teacher Sample and Prototype Testing Format

Having 69 teachers at our disposal during the Pearson Summer Institute was both an opportunity and a challenge. While it enabled the research team to gather valuable data and feedback on the prototype, conducting an investigation that is nested inside another program (with a different agenda) did create obstacles for researchers. First, with the exception of the 5 teachers brought from California to participate, researchers had no control over the makeup of the teacher sample. The nature of the institute itself predetermined that there would be a good deal of homogeneity among the teachers in terms of pedagogical skill level (all teachers of the year or nominated by CCSSO). Participants did come from a good cross-section of states, but the diversity of school types (rural, urban, poor, wealthy, etc.) was unknown to researchers prior to testing. This homogeneity may be responsible to introducing a certain level of bias in our findings.

In addition, working with these teachers, who had gathered for something other than what researchers were focused on, presented limitations on the time participants were available to perform particular tasks and perhaps on their motivation to fully concentrate on the tasks. The researchers at times felt that these limitations fractured the continuity of the testing process and made congruency in the assessment/evaluation process more challenging to maintain.

#### **Further Study and Planning**

Despite the clarity such projects bring, there is always much more to be answered and addressed. Several important planning and policy issues that emerged during the process (and are offered as recommendations in the more detailed volumes) are reiterated here. Others are offered now upon reflection of the process and the opportunities presented by the completed prototype.

#### The Student Audience

The environmental scan of other sites, as well as teacher research, made clear that students are increasingly the audience to which museums should be gearing their digital learning content. While it may be the teacher who discovers and selects the content based on classroom goals and standards, it is the student who ultimately must be engaged by it in an interactive rather than passive way. Classrooms are moving beyond the projection of digital content onto a screen to more group and individual digital exploration enabled by mobile web platforms and devices. In considering all of the aspects of the next generation tool set, SCEMS can provide leadership in this area by incorporating student-friendly language in its curated metadata and by providing learner-centered tools as part of the tool set. One example might be providing student user accounts and enabling students to create their own collections. Once such tool sets are created, beta testing should include both students and teachers.

#### Authorship and Adaptation

The opening up of SCEMS content to a more constructivist teaching approach inevitably raised issues of adaptation and annotation of content, as well as authentication. The prototype design addresses these issues by allowing for users to change the way a particular object is described within their own collection if the metadata that accompanies it is not written at an appropriate academic level for the students involved. Can/should SCEMS provide this capability? Should teachers be provided with tools to modify existing instructional content and context outside of their own collections in ways that could be shared with others?

Issues of intellectual property (IP) take prominence when such questions are asked. Indeed, these issues were considered as part of the DLRP. Contractors worked closely with SCEMS, creative commons specialists, and LRMI lead teams to address the following elements of licensing.

1. Current licensing and provisioning for sharing digital versions of Smithsonian artifacts in relation to accepted educational fair-use policy and original rights asserted against a given collection or items with a collection.

- 2. Licensing provisions for combining or "remixing" of aggregate items to produce a derivative work that modifies, repurposes, and reassigns items into new, unique educational assets.
- 3. Creation of a single, comprehensive creative commons licensing scheme for most if not all resources and derivative works identified in elements 1 and 2 above. This should include plans to package those licensing assertions to both when resources and derivative works are harvested or ingested by non-native educator use-community portals, systems, or tools.

Conversations are ongoing, but based on the toolsets being proposed, contractors recommend the following next steps:

- 1. The Smithsonian legal office should draft general terms of use to include something on educational fair use as the intended destination for all digital materials and generative works, thereby pushing use accountability to user.
- 2. SCEMS should not provide any tools that allow for the digital editing or modification of any digital objects or images (revising tones/shades through various filters, stretching, pixilation, etc.)

### Partnerships and Data Sharing

Recommendations regarding the formation of strategic content partnerships and the sharing of metadata made in the "Review of Literature and Technical Requirements" document (Volumes I & IV) bear repeating. This type of activity could prove beneficial to SCEMS and to the Smithsonian at large.. Further work and study should be prioritized in order to:

- Define business models or benefits to Smithsonian for sharing with particular partners.
- Develop list of potential partners.
- Implement LRMI 1.0 tagging and markup conventions.
- Create outreach strategy and metrics to monitor success.
- Provide single-point, curated metadata to partners in multiple, machine-readable formats.
- Continue Smithsonian publication data in Learning Registry framework.

### Mobile Web and Media Strategy

Recommendations for next steps regarding a mobile web and media strategy were also made in the Review of Literature and should be reiterated. Trends in the use of social media and mobile phone and tablet use in schools is expanding and gaining greater acceptance. It is critical that a strategic approach to web, community and mobile learning should be taken before large investments are made. SCEMS should consider the following preliminary steps:

• Incorporate mobile-friendly features in current site content and functionality.

- Mimic iPhone Rolodex or gallery views to assist with later potential mobile device integration.
- Research the extent to which teachers would use social media to contribute content to the site.
- Research the extent to which teachers would share content or participate in online communities.
- Consider emerging trends such as geolocation tools and augmented reality for the K-12 mobile learning audience.
- Examine carefully the specific value-added of any mobile learning application along with costs associated with its on-going management, weighing them against the advantages of mobile web investments.

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