Smithsonian Center for Education and Museum Studies
Digital Learning Resources Project

Volume III
Report of Findings
Teacher Research and Prototype Testing
October 2012
v.1.0

Smithsonian Center for Education and Museum Studies

CROSS & JOFTUS

Abstract

This report describes the outcomes of the *Digital Learning Resources Project*, a research endeavor of the Smithsonian Center for Education Museum Studies (SCEMS), supported by generous funding from a Smithsonian Youth Access Grant administered by the Office of the Assistant Secretary for Education and Outreach, with contributions by the Pearson Foundation, Brokers of Expertise of the California Department of Education, and the Council of Chief State School Officers.

A series of studies grounded in a literature survey and environmental scan, and consisting of two phases of teacher interactions, informed the design and final specifications for the smithsonianeducation.org next generation prototype. Findings are discussed for two phases of the Digital Learning Resources Project (DLRP) with teacher groups. The first, found in Part A of this report, describes the findings from a Teacher Research Group (TRG) of 20 educators in California in the spring of 2012. The second, found in Part B, describes the prototype testing of 69 teachers in Washington, DC in the summer of 2012. The patterns of behavior observed and recorded during these two phases enabled developers to design initial prototypes grounded in research and then test and revise those prototypes.

The resulting prototype design provides more efficient and intelligent search and visualization features and ways for users to save, share, and annotate personalized "collections" on the site. The prototype also offers alternatives to the fully assembled lesson plans available on the site by incorporating a set of lesson-building tools and interactive modules that can be wrapped around those collections.

Project Team

PROJECT DIRECTORS

Smithsonian Center for Education Museum Studies
Darren Milligan, Senior Media Designer/Webmaster
Michelle Smith, Director of Digital Media and Publications

Navigation North Learning Solutions, LLC
Joe Hobson, Director/Owner
Brian Ausland, Director of Educational Research and Strategic Initiatives

Cross & Joftus, LLC
Christopher Cross, Chairman
Virginia Adams Simon, Senior Associate

PROJECT TEAM

Smithsonian Center for Education Museum Studies
Pino Monaco, Director of Program Evaluation and Audience Research
Melissa Wadman, Manager of Program Evaluation

Navigation North Learning Solutions, LLC
Daniel Krieger, Engineer
MaryRose Lovgren, Education Consultant

Cross & Joftus, LLC
John Ittelson, Professor Emeritus, California State University, Monterey Bay
Clark Quinn, Executive Director, Quinnovation
Dilan Maherdran, Post-Doctoral Candidate, University of California, Berkeley
Virginia McMunn, Teacher/Consultant
Griffith Montgomery, Education Specialist
Jillian Ryan, Teacher/Consultant

The Digital Learning Resources project is funded by a Smithsonian Youth Access Grant administered by the Office of the Assistant Secretary for Education and Outreach, with contributions by the Pearson Foundation, Brokers of Expertise of the California Department of Education, and the Council of Chief State School Officers. This document is the third of five parts. For all of the project documents, please visit the *Digital Learning Resources Project* wiki at http://smithsonian-digital-learning.wikispaces.com/. The *Digital Learning Resources Project* wiki is designed to involve internal and external stakeholders, experts, and educators everywhere

in the development of this project; provide a transparent, fast, and durable medium for project development and refinement; and to demonstrate the potential of an open, public process.

Table of Contents

Appendix Under Separate Cover

Figures **Page**

Images

Smithsonian Center for Education and Museum Studies
Digital Learning Resources Project
Report of Findings

Background

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, the main feature of which 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 including lesson plans, video and audio clips, and interactive instructional games is one of several Smithsonian finding aids such as its Collections Search Center (7.89 million catalogue records, 779,100 images). Other Smithsonian websites offer digital collections and tools in specific subjects and collections; the Center's unique goal is to provide access to all Smithsonian resources that are designed for 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.

Structure and Purpose of Report

The following report describes a series of findings that informed the design and final specifications for the SCEMS next generation prototype. Findings are discussed for two phases of the Digital Learning Resources Project with teacher groups. The first, found in Part A of this report, describes the findings from a Teacher Research Group (TRG) of 20 educators in California in the spring of 2012. The second, found in Part B, describes the prototype testing of 69 teachers in Washington, D.C., in the summer of 2012. The patterns of behavior observed and recorded during these two phases helped developers design initial prototypes grounded in research and then test and revise those prototypes. 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 and environmental scan are available as separate volumes (I and II) produced for the project. The relatively small sample size utilized (approximately 89 teachers in total) does pose limitations on the ability to generalize the findings reported here. However, when taken together with previous research conducted by SCEMS and available user analytics (based on work with thousands of teachers), the outcomes offer clear insights and frameworks for other museums interested in pursuing similar questions.

Previous Research Findings

Previous research and data made available to SCEMS regarding user opinion and usage were an important starting point for the DLRP. Researchers examined survey data collected by Foresee from 2009-2011, the *Remedial Evaluation of the Materials Distributed at the Smithsonian Institution's Annual Teachers' Night* conducted in 2010, and user analytics made available through Brokers of Expertise in 2012. Each asks different questions and provides its own insights, but taken together, these reports provide a clear consensus as well as questions for further exploration.

Foresee Survey and Teachers' Night Findings

SCEMS has conducted regular evaluations over the years to better understand the needs of users and to make improvements on the site. User opinion was collected through the Foresee Survey, a data set of over two thousand users of Smithsonianeducation.org between March 2009 and March 2011. The Foresee Survey was designed to address user habits, needs, preferences, and reactions to Smithsonianeducation.org. The *Remedial Evaluation of the Materials Distributed at the Smithsonian Institution's Annual Teachers' Night* (Ito, Langa et al. 2010) was also reviewed to investigate similar patterns of opinion and teacher use of digital resources. The Remedial Evaluation incorporated not only survey results, but also focus group and observational data and was designed to surface answers to questions about design elements that appeal to teachers and the extent to which teachers use the Smithsonian lesson plans as presented.

Despite the differences in design and goals of these two studies, consistency was found across the two data sources in two categories: 1) the types of resources that teachers are looking for; and 2) the types of learning experience teachers are seeking from digital resources.

Preferred design elements of content and materials and the extent to which teachers use Smithsonian lesson plans were addressed by the Teachers' Night focus groups only. Issues regarding the usability, navigation and findability of content within the SCEMS site were raised by the Foresee survey results, and not addressed in the Teachers' Night evaluation, therefore, could not be cross-referenced.

Types Of Resources Sought

In evaluating what types of digital content assets teachers find most valuable, findings from both the Foresee survey results and the Remedial Evaluation show a need for content that is more visual than text-based, cross-disciplinary, and aligned with standards, with topic-specific background information.

Sample Foresee Comments:

- "More information please, and more pictures."
- "Less words, more pics!"
- "Provide a search engine that can identify art [or resources] from a time period."

Sample Teachers' Night Focus Group Comments:

- "value of material being fun to use"
- "user friendly"

- "interdisciplinary"
- "adaptable"
- "aligned with standards"
- "able to be accommodated to students with diverse learning needs"

Type of Experience Sought

Teachers in both studies commented on the need for experiences to be engaging for a diversity of students and not dependent on a museum visit. Student engagement and interaction were the top priority for teachers. One Teachers' Night respondent asked for "something that is more interactive instead of reading the book or looking just at pictures. Getting hands-on, where they can set up their own little aquarium…" as one-way to engage students in science learning. A very small number of comments from the Foresee survey indicated a need for 21st Century compatibility (e.g. mobile apps and iPads) and a virtual experience (virtual museum tours or live video feeds of events). Given the current trends in these types of tools and devices as described in the literature, this raised additional questions, which needed to be explored with DLRP teacher researchers.

Design Elements Preferred by Teachers

In considering design features of the site, student interest and visual appeal were again emphasized by teachers in Teachers' Night focus groups:

> "The elements that make them [the lesson plans] more appealing include having high quality, iconic pictures; being able to laminate the posters or cards; being hands-on or tactile in some way; and being versatile."
>
> "It's hard to over-emphasize how visual kids are now. They have to see images. If they are not seeing images, they are not interested."
>
> "Everything needs to be taught using visual, auditory, and kinesthetic, because every child learns differently."

How Teachers Make Use of Materials Provided by Smithsonian

Teachers in the 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%). 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, 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 SI assets.

Search, Save and Share

Visitors to Smithsonianeducation.org also rated their satisfaction on a 10-point scale in using the site across several domains. The highest areas of satisfaction were in content (accuracy and quality) with an average score of 8.6 and in site performance (quick load time, lack of errors,

consistency) with an average score of 8.7. Lowest areas of satisfaction were in navigation (organization, number of clicks to find resources) with an average score of 7.9, and in look and feel and functionality both with an average score of 8.3. User comments range from problems with error messages, to lack of information and clarity regarding the resources.

These previous findings intersect in multiple ways with the literature on digital learning and museums cited earlier. 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.

User Analytics

User analytics available through Brokers of Expertise represent the behaviors of approximately 1,575 teachers who view most of the 2,000 SCEMS resources through the site.[1] These statistics show which of the SCEMS resources are being viewed and accessed the most, which are being "favorited" or "watched," and which have teacher comments attached to them. These categories enable us to assess the value of certain digital assets for teachers, and to some degree, the findability of those assets.

The two most fully accessed resources by this analysis are "1846: A Portrait of a Nation," from the National Portrait Gallery, with 193 views and 69 full accesses and "How Big Is Our Universe" with 322 views and 62 full accesses. "How Big Is Our Universe" is also the most favorited (7 users) (Figure 1).

There are a high number of views of each resource in comparison the number of full accesses (the highest being 35%). This raised the question of visualization of resources and how this affects the user's pursuit of the content. When a teacher views the title or thumbnail of the resource, what information helps them take the next step to fully access the resource? Do these views enable teachers to quickly analyze a resource for its relevance to their lesson? This was a question that researchers investigated in the ensuing months of the project. One note of caution: Since these assets were searched through Brokers of Expertise, findability questions raised here may not apply to the Smithsonianeducation.org site.

If we examine most favored resources, we see assets that offer varying levels of flexibility for teacher adaptation and student use. "How Big Is Our Universe" takes users through a series of pages which contain helpful exercises and interesting historical facts to help them gain perspective on how humans have viewed their place in the universe historically. Pages can be printed out and used as handouts in class or students can interact on the site and move through the pages themselves. "1846: Portrait of a Nation" is a simpler resource focused on high- quality images with surrounding text. This resource is not interactive but could be used as a supplemental resource for building a lesson. Yet another asset that is favorited (by 3 users) is "Principles for Principals" an 8-part video resource for principals who are looking to improve math programs in their schools. Why these resources are appealing to teachers more so than others is unknown when viewing these results in isolation. The literature does, however, support

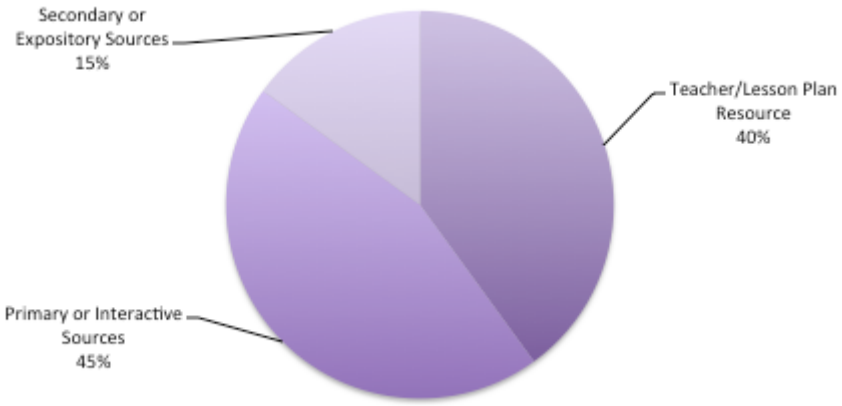
[1] It is estimated that 25% of BoE (6,300) user base has accessed Smithsonian resources

teacher interest in resources like “How Big Is Our Universe?” that enable both whole class and individual student delivery methods (Buffington, 2007; Leftwich & Bazeley, 2009).

Figure 1. Smithsonian Resources Marked ‘Favorite’ on BoE

Resource Name	Views	Full Accesses	Favorites	Watches	Comments	Collection
How Big is Our Universe? An Exploration through Space and Time	322	62	7	2	2	0
Principles for Principals	86	19	3	0	1	0
19th Century Lithographs: America on Stone	152	181	1	0	0	0
A Brush with History Teaching Guide	134	32	1	0	0	0
Art to Zoo: Tomorrow's Forecast: Oceans and Weather (1995)	133	31	1	0	1	1
A House Divided: Civil War Photography	114	15	1	0	1	0
Separate Is Not Equal: Brown v. Board of Education, Electronic Field Trips	109	18	1	0	1	0
A More Perfect Union Collection Search	100	24	1	0	0	0
A Brush with History	99	20	1	0	0	0
Galaxy Clusters	98	8	1	0	1	0
Worm Watching	94	13	1	0	1	0
Art to Zoo: Using the Yellow Pages as a Teaching Resource (1988)	90	29	1	0	0	0
Tour the Universe	89	19	1	0	1	0
Ape and Primate Glossary	88	51	1	0	0	0
A Monumental Assignment	88	22	1	0	0	0
Food Web: Hold the Anchovies	85	18	1	0	1	0
Jamestown, Quebec, Santa Fe: Three North American Beginnings	83	11	1	0	0	0
Smithsonian Jazz Class: Benny Carter	76	17	1	0	0	0
Louis Armstrong: A Cultural Legacy	76	14	1	0	0	0
American Indian Heritage Teaching Resources	75	9	1	0	0	0
A More Perfect Union	73	16	1	0	0	0
Theatre, Motion Pictures and Television: Highlights from the Archives Center Collections	72	21	1	0	0	0
Earth 2U, Exploring Geography—People Power! Making Geography	72	16	1	0	0	0
SOS Handbook	71	3	1	0	0	0
Latino Virtual Gallery	67	20	1	0	0	0
Word Search	60	28	1	0	0	0
I Spy in the Sky	58	9	1	0	0	0
Rebels: Painters and Poets of the 1950´s	49	4	1	0	0	0
Vote! The Machinery of Democracy	48	10	1	0	0	0
Postal Pack for Elementary School Students	47	4	1	0	0	0
The Annenberg/CPB Channel	46	4	1	0	0	0
Human Origins Program: In Search of What Makes Us Human	36	6	1	0	0	0
Living and Working in Space	31	5	1	0	0	0
National History Day	26	1	1	0	0	0
Life in Ancient Greece Reflected in the Coinage of Corinth	22	4	1	0	0	0
Losing Ground	16	2	1	0	0	0

Figure 2
20 Most Viewed Resources on BOE By Resource Type



The user analytics point to an interesting difference between what earlier teacher groups reported looking for and what BoE users were tracked as viewing and accessing most often, raising questions for further exploration. BoE users viewed only slightly more primary and interactive sources than lesson plans (45% and 40% respectively). Foresee respondents did not report seeking high numbers of interactive modules. Note also in Figure 1 the high level of views as compared to the number of full accesses. How teachers decide between what they are initially seeking, and what they extract and ultimately feel they can use in their classrooms remained an open question to be explored by the DLRP.

Literature Overview

A current review of the literature supported the conclusions of this previous research regarding teacher use of museum lesson plans, but also offered some new perspectives on digital learning, data and content sharing, metadata management, and the mobile web. The full review is available for download on the project wiki: http://smithsonian-digital-learning.wikispaces.com/.

The summative points and final recommendations based on this review are as follows.

21st Century Learning

When examining specifically how teachers utilize museum lesson plans we find agreement with previous findings. Museum research in both the U.S. and abroad (Buffington, 2007; Kelly & Breault, 2007) from the last five years, reveals that teachers seek lesson plans and ideas that:

- Are related to concepts or big ideas,
- Are closely linked to both state and national standards,
- Are interdisciplinary,
- Do not require a museum visit,
- Have educational value,

- Offer simple designs and language,
- Utilize easy-to-search databases, and
- Contain materials that are easy to download and free from copyright issues.

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 (Horwitz & Intemann, 2007; Leftwich & Bazeley, 2009).

The Importance of a Good Search

If teachers are looking for sites that offer simple designs and easy-to-search databases as the above findings point out, the importance of a good search must be examined as part of the discussion. Exciting and engaging digital resources are not worth much to teachers if they can't find them. Studies examining the usability issues of museum websites have pointed out a number of common problems with website designs that impede users' ability to effectively search and find what they were looking for which may be applicable to DLRP evaluation findings (Marty & Twidale 2004; Solas 2010; Masri & Grossman 2009). Literature on shared metadata and open educational resource repository communities is still emerging, but has been supported by recent philanthropic and government efforts such as the Learning Registry, a joint venture between the U.S. Department of Educational Technology, the Department of Defense, and the Shared Learning Infrastructure (SLI) project funded by the Gates Foundation.

Connecting Content to Site Architecture

Many museums are still wrestling with the same issues of findability on their websites, but simple, affordable tools are now available to organize content more dynamically.

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.

Promoting Effective Metadata and Visualization

Museum collection websites have tended to be either "heavily authored" with a very strong, prescriptive voice and structure, or as fairly uninformed, uninterpreted digital databases lacking context. Online collections are often categorized in relation to collection-type metadata that describes the object, its location, inventory number, etc. Social tagging is a way to bridge this gap in online collections and make databases more searchable by their intended audience (Trant & Wyman, 2006). Early studies of the value of this social tagging, sometimes called "folksonomies," found evidence that it was offering a number of benefits to both users and museums (Al-Khalifa & Davis, 2006).

Large digital collections must also consider issues of visualization of content to facilitate the user's ability to analyze the value of their search results. Urban, Twidale and Adamczyk

(2010) discuss examples of collection dashboards produced by various museums, libraries, and archives. Creating dashboards to display search facets, counts, and images along with other relevant data from the collection helps audiences more easily analyze the relevance of the content to their needs.

Distributed Curation and Data Sharing

Sharing open educational resources and building communities of learning are central components of 21st 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 and accessibility for SCEMS resources as well as the larger SI collections database will require increased efforts to form strategic partnerships and share data within these infrastructures and others (Miller & Wood, 2010; SRI International, 2012; Masri & Grossman, 2009).

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

Partnership Development

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 resources (Gaynor, 2012).

21st Century Tools and Trends

Open educational resources are challenging traditional museum conceptions of audience and interpretation. In 2011, the Horizon Report looked at issues at the forefront in wider education circles beyond the museum world. Their findings show that resources and relationships are being made increasingly available to teachers and students through the Internet, ebooks, mobile devices and social media. People expect to be able to work, study, and learn whenever and wherever they want, challenging traditional notions of schooling and the workplace. Technologies are also increasingly cloud-based, resulting in a decentralization of IT support beyond the sponsoring institution (The New Media Consortium, 2011). The Horizon Report tracks the "time to adoption" of new media trends in education each year on three scales: One year or less, 2-3 years, and 4-5 years. In 2010, the report cited mobiles and social media as trends to watch in museums that were within one year or less of adoption.

Content Creation and Sharing

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. 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, Thompson et al., 2008).

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).

Mobile Internet

Rapid growth in usage of mobile 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.

Mobile apps can be powerful tools for drawing attention to your website, but you must be clear about the "added value." 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. 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, M, Devitt, S. & L.Wu, 2010).

Conclusion and Recommendations

The conclusions and recommendations of this review of literature fall 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) instructional tools and web trends and devices which bear consideration for the next generation of the SCEMS site.

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 the intended audience.

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.

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.

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.

Best Practices in the Field

To gain insight into the current trends in digital learning, an Environmental Scan was conducted as part of the DLRP. A list of 32 websites for review was culled from recommendations of the SCEMS staff, Cross & Joftus, and Navigation North contractors to provide a broad spectrum of sites to which K-12 teachers are exposed. The sites fall into three categories: 1) Museum Education Sites, 2) General Education Resource Sites, and 3) Digital Collection Sites. The collections sites were chosen as a useful comparison to the large museum digital repositories operating in the same space as the Smithsonian Collections site http://collections.si.edu/search/index.htm. The education and museum websites were chosen for their potential to offer models of best practices that could be replicated. The full list of sites reviewed is included as Appendix A. The full Environmental Scan is available for download on the project wiki: http://smithsonian-digital-learning.wikispaces.com/.

Findings

While museum sites are continuing to make advancements in developing and deploying tools that allow educators the means to independently save and share e resources, few have moved to provide independent organization of resources and curriculum elements within their sites or systems. Museum sites still serve as a primary publishing point for curriculum collections and materials as generated by centralized, internal teams, and those materials are largely deemed effective and comprehensive by educator audiences. Yet, research shows that greater learning gains are achieved when digital resources successfully integrate tools for student-teacher collaboration in conjunction with institutional curation of those very same resources.[2]

The number of museums electing to integrate interactive tools in relation to the assets of their collections, however, remains modest. As teachers continue to make resource modifications and produce supplementary materials to create more accessibility for more students, those modifications and guidance resources that promote deeper student discovery and interaction with the resources go largely unknown. The focus of this review and analysis is on some of the more popular museum-related resource sites and the steps they've taken to promote discoverability through established taxonomies like instructional subject lists or content standards, user-directed organization of content for presentation to students, and development of instructional items and interactive components.

General Education Sites

The general education resource sites differ in their approach to audience. Where the museum sites reviewed tend to be more focused on the teacher-user, the education sites reviewed tended to be designed with a broader audience in mind, which would include the student and

[2] http://projectred.org/about/research-overview/findings.html

sometimes parents. For example, within some general education sites, teachers are able to create a l class portal and reorganize or package the resources to create personalized learning activities. These portals can then be shared with the class for student-driven inquiry, putting the resources and the experience directly in the hands of the learner. Museums are beginning to offer these features as well, but the museum perspective on the audience still focuses largely on the teacher as the main user and interpreter of content.

Another approach used by education sites was to initiate pre-designed layers or areas of the site for students to explore content on their own. A feature that enables users (be they teachers or students or both) to create and customize a section on a site might be considered for inclusion in the Smithsonian prototype feature set. With this approach in mind, considerations would need to be made in the areas of modifying the collection-asset parameters for various audiences, modifying design, and potentially creating differing metadata and discrete search features for teachers and students.

Digital Collection Sites

The digital collection sites offer the deepest and most expansive digital collections. These sites contain thousands of resources (primary, audio, visual, text, etc.) that have been curated from numerous individual collections. Many of the sources are other museums, databases, archive collections, national libraries, and user-generated content (i.e., archive.org). Such extensive data is a strength of these sites; at the same time, however, some of the sites appear cluttered or are difficult to navigate.

Best Practices Examples

Despite the lack of examples of sites that excelled in all areas of the best practice criteria, reviewers did choose some sites that they felt exemplified best practices in particular ways. Below we highlight just a few:

DocsTeach is an example of best practices for toolset design. Created and maintained by the National Archives, it is visually appealing and offers multiple ways for teachers and students to interact with primary source documents to create engaging lessons. The site provides templates for lesson building that can be adapted, annotated, and personalized by the teacher. Correlated to National History standards, the site offers Bloom's taxonomy as a teaching tool to ensure rigor and deeper learning of concepts. Thousands of primary source documents are ready to print or to use within an educator-designed, 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 educators' activities (with their supplemental notes added in when they create 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 are available on the home page. 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. It uses large icons and simple words.

ArtNC of the North Carolina Museum of Art is another example of best practices for lesson-building toolset design. This site allows the user to build concept maps around works of art. ArtNC includes features that enable users to assemble the resources for use within the classroom by providing the user with the ability to customize resources for classroom instruction and implementation. These "concept maps" list grades, subjects, and concepts, and can be used within a class to teach such educator-designed concepts as family, cycles, and interdependence.

It also includes lessons that 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. ArtNC has been recognized as especially helpful to teachers of special education students. *Easy Approaches to Teaching with Objects* offers important differentiation for those students. Concept maps are a means of building comprehension for a text.

Gooru Learning, operated by independent non-profits, succeeds in bringing together multiple contributor sites and creating harmony and an intuitive interface. Search results appear as thumbnails that are categorized under headings for each type of digital resource (e.g., videos, interactives, quizzes). Gooru also has an excellent feature that displays partner resources in an applet within Gooru. This saves the user time by eliminating the need to navigate back and forth between Gooru and any external sites.

Khan Academy is a non-museum site highlighted also for its approach to teacher and student interactives. The video-driven resource database is designed for students' independent use. Khan Academy's innovation in regard to digital technology in the classroom stems from its ability to track student usage and send reports to teachers. In fact, this ability has proved useful for several schools in the San Diego Unified School District, where classrooms are using the videos as content reinforcement in a flipped classroom environment. One school in particular is considering a model in which math students would be responsible for watching the instructional video that comes with a lesson, then performing the practice equations in class the next day under the guidance of the instructor. This situation is called "flipping" because it allows for instruction to occur at home while practice is completed in class. In ideally flipped classrooms, they allow for personalized instruction with more hands on help from the instructor.

Prototype Implications and Market Position

Regardless of the type of web-based resource site reviewed, the effort was to process each through a common set of cross-filters and analyze the methods in which they provide users access to resources, as well as use, annotation, and integration of resources in external communities or systems. The descriptive framework to capture distinguishing characteristics encompasses many features, but as has been cited earlier in this document, we have opted to identify four general categories. Below is a comparative analysis of those categories comparing the existing SCEMS system to a general selection of four reviewed sites deemed Best Practice examples from various segments of this environmental scan. These Best Practice sites—Khan Academy, Gooru, DocsTeach, and ArtNC—also possess components that might be good models for the eventual prototypes to be developed. (In each of the categories, systems were assigned the symbol + for "advanced provision," the symbol ✓ for "provision," and the symbol - for "no or limited provision.")

Figure 3. Best Practices Comparison

Category Description	SCEMS	Khan Academy	Gooru Learning	Docs Teach	ArtNC
Multiple Search Modes and Ease of Navigation	✓	+	+	✓	✓
Customization of Resources for Classroom Instruction and Implementation	–	+	✓	+	✓
Opportunity to Interact with Content and Promote Advanced Online Learning Exchange	–	+	+	+	✓
Opportunity to Share Instructional Modifications and Supplements Online	✓	+	+	+	✓

Researchers recommend utilizing some of the sites highlighted here (and in the full review of sites) as part of the prototype testing regime to record broader teacher response and feedback that can inform prototype design.

Part A- California Teacher Research Group

The above findings served as the foundation for subsequent work. The user analytics and surveys provide one level of understanding of how teachers are using Smithsonian resources. User analytics tell us which resources are popular, but not *why* they are popular. The Foresee survey data and Teachers' Night results tell us about how teachers respond to the smithsonianeducation.org site in its current form, but not about what is possible. And no data exist on exactly *how* teachers interact with the site and its assets. This limits the available ways of truly understanding teacher behavior and creating a cutting-edge toolset that meets their needs. For this, we look next at the work of the Teacher Research Group convened in Northern California.

Project Design and Methodology

The next step in the design of the DLRP research was to take the foundational understanding gained through prior investigations and apply it to a focused and deeper process of teacher inquiry, exploration, and evaluation. The teacher group was involved in an iterative series of investigations and evaluations, which resulted in lessons designed by the teachers using Smithsonian assets. The research team employed a combination of heuristic, quantitative, and qualitative measures, utilizing surveys, observation, focus groups, and monitoring of online conversations in order to capture a range of interactions. [3]

A central tenant of the research design and methodology of the *Digital Learning Resources Project* was to listen carefully and watch closely the behaviors of teachers in the digital learning space with a variety of methods of information gathering to triangulate the outcomes. Rather than using a large sample of teachers and conducting more traditional survey research, the first phase of the project involved identifying a group of teachers to serve as an intimate research group. The primary goal of this deeper observation and feedback was to surface more actionable recommendations that could be further studied with a larger sample of teachers gathered for the Pearson Summer Institute "Mission Possible" in Washington, D.C., in Phase 3.

Teacher Sample

The identification of this teacher sample occurred through established online education communities included within the Brokers of Expertise (www.myboe.org) network, utilizing relationships with the Brokers of Expertise (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). See figure 3. 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.

[3] See Leftwich & Bazley (2009) *Pedagogy and Design: Understanding Teacher Use of Online Museum Resources*. Museum and the Web Conference 2009.

Figure 4
Teacher Research Group Grade and Subject Area

Subject	Grade		
	K-6	6-8	9-12
All	9	3	
English/L.A.			1
History/Soc. Studies		1	1
Science			3
Eng. Language Development			2
Special Ed.[4]		1	1

Two-Tiered Inquiry and Evaluation Design

TRG members engaged in a two-tier iterative cycle of inquiry, use, and evaluation. This involved participating in a series of common use-regimens as coordinated in-person 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 include:

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.)?

Tier One Inquiry, Use and Evaluation Cycle

In a pre-survey, TRG members answered quantitative and open-ended questions about their typical use of educational technology, both at home and in the classroom. They were also asked about the students they taught. (Pre-survey protocol is attached as Appendix E). Next, the TRG was asked to attend one of two workshops where they were introduced to the project and began their work. Each teacher registered on the BoE site and joined the research group page (http://myboe.org/portal/default/Group/Viewer/GroupView?action=2&gid=2555). This was the group space for their sharing and discussions in the ensuing month. At the workshop, teachers searched for Smithsonian resources using Smithsonianeducation.org, Brokers of Expertise, Thinkfinity, Gooru, or OER Commons. Their task was to surface resources to use in their classrooms. While conducting searches, they used a "Resource Annotation Key" (Appendix F),

[4] Teachers in the areas of Special Ed and ELD taught in combination with a core content area.

which enabled the team to document their behaviors and collect an additional level of user behavior data.

Tier Two Inquiry, Use and Evaluation Cycle

The second tier of investigation, 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., for the classroom, 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 resource findability, teacher preferences, and teacher habits when constructing a lesson with digital resources in general and Smithsonian resources specifically.

Online Conversations

To gain deeper insight into the analyses teachers use when they worked independently, the online community space in BOE was utilized as a virtual meeting place to continue the conversations begun in Tier I. TRG members were asked to engage in ongoing discussions throughout the course of the project. As they continued to search and select the resources they would eventually use, they recorded their excitement and frustrations, as well as the factors that influenced their choice of resources.

Selecting, Sharing and Teaching with a Smithsonian Resource

Teachers selected two resources and prepared lessons for one. They shared their lesson plans with the group. After teaching the lesson, they reported their successes, failures, and reflections. This virtual "fishbowl" approach enabled the research team to observe and respond as part of the online community throughout the process.

From the TRG, five candidates were selected to participate in Phase 3 prototype testing during the Pearson Summer Institute. The considerations for the selection included experience and expertise in curriculum and instructional design, technology proficiency, and experience teaching with technology-based resources. Particular attention was also paid to the level of detailed feedback and proposed feature/tool articulation during Phase 2 experiences and their specific experience executing the classroom application of Smithsonian digital learning assets prior to and as part of the more rigorous Phase 2 regimen elements.

Post-Survey

After teaching with the resource and discussing the experience on BoE, TRG members completed a post-survey to describe their choices and experiences with implementing the resource in more detail. (Post-survey protocol is attached as Appendix G.) These responses were meant to further solidify findings gathered through observation and online discussions.

Focus Groups and Interviews

Following each workshop, a focus group was conducted to gather insights and feedback on what teachers found, what their challenges were, and their ideas about how Smithsonianeducation.org might be improved (Focus Group Protocols are attached as Appendix H). Also, at the conclusion of this phase, a set of in-depth interviews was conducted with four of the five teachers who were selected to travel to D.C. for the Pearson Summer Institute. These

interviews enabled teachers to talk in more detail about their experiences in building and teaching a lesson with a Smithsonian resource and to expand on their responses to the post-survey. They also shared examples of student work from those lessons. All of the focus groups and interviews were videotaped. The video of the final interviews is available for public viewing on the DLRP wiki: http://smithsonian-digital-learning.wikispaces.com. Figure 5 below summarizes the cycle steps for the two tiers.

Figure 5. Phase 2 Inquiry and Evaluation Cycle

Tier 1 Inquiry and Evaluation Cycle Steps

1. Pre-survey of identified teachers
2. Regional face-to-face introductory workshop
3. Create online community space with other participants
4. Identify 3-5 resources
5. Evaluate resources
6. Focus group

Tier 2 Inquiry and Evaluation Cycle Steps

1. Return to classroom
2. Create appropriate instructional material using one of the resources evaluated in Tier 1
3. Evaluate results
4. Share instructional material and results to online community space
5. Post-survey
6. Interviews with selected teachers

Analysis

While survey data, annotation sheets, and user analytics were analyzed using simple summative analyses, the qualitative data collected from the twenty teacher researchers (focus group discussions, observations of online conversations and live workshops) were analyzed using complementary coding and pattern recognition methods (Coffey and Atkinson 1996). Videos, notes, and online views were analyzed by extracting meaningful quotes and analyzing them for repeating terms such as "I tried,""I found," "I decided," "I shared," "I used," etc. Teacher behavior data were further reduced and classified according to these patterns under the research questions. From this level, findings were connected to one another and the larger working framework, then further cross-referenced to the literature and previous findings to articulate preliminary prototype considerations. Two members of the research team performed these analyses independently to check for inter-rater reliability.

Findings

What the TRG experience afforded researchers was the opportunity to confirm earlier findings, fill in some important information gaps, and provide a more detailed and nuanced view of how teachers interact with Smithsonian resources. This small group of teachers showed very similar responses to the earlier research and literature findings in what types of resources they

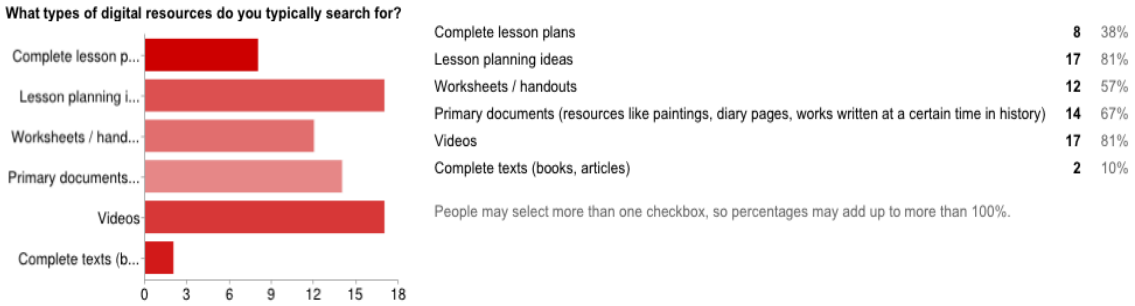
value, how they search for them, and how they use them in their classrooms. The TRG filled an important gap in understanding more about *why* teachers choose particular resources and how they analyze them. They also told us more about their sharing and community practices – answers that were missing in the literature and previous data. These central questions about what teachers are looking for, how they search, analyze, and use digital resources were probed in multiple ways, therefore our findings integrate both qualitative and quantitative responses.

What Are Teachers Looking For?

Before examining the search process, it is important to determine what users are actually looking for most frequently. This influences the way they go about searching for those assets, and it tells SCEMS what types of assets to pursue for curation. A good deal was known about this question already as a result of the previous research and review of literature. These findings served to confirm those earlier findings.

TRG members prefer lesson ideas and primary source materials. Eighty-one percent (81%) of respondents were looking for lesson plan ideas, primary source documents, worksheets, and printable handouts and had a stronger preference for images and videos (see figure 6). When asked to choose two resources to use in their classrooms, eleven of the forty resources chosen (36%) were images from the Smithsonian collection. This was the most popular type of resource chosen. Five (12.5%) complete lesson plans were chosen, and the same number of videos was chosen (see figure 7). This finding is also consistent with the literature which describes teachers' interest in using museum images as the basis for their lesson planning, as well as the tendency for teachers to take pre-packaged lesson plans apart and re-purpose them to fit their needs (Horwitz & Intemann 2007; Leftwich & Bazeley 2009). It should be noted, however, that the previous findings of the Foresee survey data show a more even split between teachers wanting full lesson plans and those wanting lesson planning ideas or supplemental materials.

Figure 6
Resource Preferences of Teacher Research Group by Type [5]



[5] Pre-survey responses

Type of Resource	
Complete lesson plan	5
Online interactive / game	1
Image	11
Primary source document	4
Website with various media	3
Video	5
Idea for an activity	7
PowerPoint	1
Lab	1
Worksheet with Assessment	1
Interactive tour	1
Resource for details	1

Figure 7: DLRP Phase 2, Post-Survey Results. Type of Smithsonian Resource Chosen for Lesson

How Do Teachers Search?

Just like the Teachers' Night and Foresee results, the TRG findings suggest that teachers are happy with the *quality* of the resources they are identifying on Smithsonianeducation.org, but *finding* the resource takes persistent effort and often leaves teachers frustrated. This is problematic for building a sustained presence on the site and fostering loyal return-users.

The DLRP observations and teacher annotations gave us a closer look at how teachers search. TRG members used a variety of methods to search for resources, but most (74%) started with placing a term in the search box, then applied further filters by grade and subject. More than half (65%) of the TRG also searched through the standards browser. Focus group comments revealed that this method tended to be more successful in yielding more resources for those teachers than the general search method. These responses highlight the common problems facing museums in designing databases for their large digital collections. They reveal, too, issues discussed in the literature related to tagging, viewing, and metadata management (Marty & Twidale 2004; Solas 2010; Masri & Grossman 2009).

TRG members did not, in general, begin by looking for a particular content partner. Only 21% said they searched by a specific collection partner. This could be interpreted to mean that teachers have no "brand loyalty" when it comes to certain repositories, as long as the provider consistently offers them what they are looking for.

When the TRG participants reflected (in focus groups, online conversations, and annotation sheets) on their experience of searching for specific resources during the workshop, they shared both disappointments as well as appreciation for the high quality of the resources they identified. Gooru Learning and OER Commons, two sites identified by the environmental scan as offering sophisticated search tools, were also used by TRG members to find Smithsonian resources. Focus group comments showed an appreciation in particular for Gooru's "playlist" tool which allows the user to save their searches in categories created by the user like a music playlist.

TRG members suggested the following features to improve the findability of resources:

- 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

How Do Teachers Analyze Their Choices?

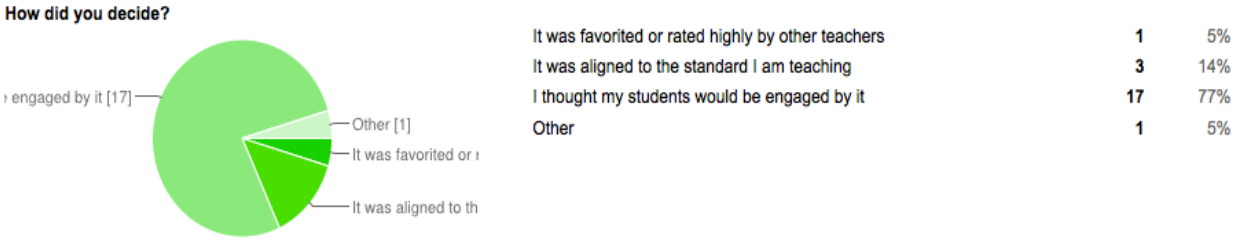
How do teachers decide what resources will work best for them in their classrooms? How do they assess the relevance to their students and teaching goals and standards? Researchers were particularly interested in these questions due to the lack of information from previous findings or the literature on this topic.

Following the initial workshop, TRG members participated in online conversations about their continued search for resources and their decision-making process for choosing the best Smithsonian asset to incorporate in a lesson. Patterns emerged in these conversations that show us similar considerations across the TRG sample. These considerations can be categorized as follows: 1) authenticity and Engagement, 2) creating a Virtual Museum Experience, 3) coherence and consistency, and 4) text vs. non-text experiences.

Authenticity and Engagement

In order to choose a resource, a teacher will analyze it for its ability to grab a student's interest (see figure 8). Seventy-seven percent (77%) of the teachers in the TRG cited this as their reason for choosing the resource. This trumps other measures like ratings and the opinion of colleagues. TRG members consistently discuss a desire for resources to also serve as (or provide) independent, student-driven tools. This means the student becomes the scientist or historian, and the teacher serves as the coach.

Figure 8: Teacher Research Group Post-Survey, How Did You Decide?



TRG members revealed their use of Smithsonian images, videos, interactive modules, and activities as a supplement to provide real world experiences and to increase engagement. One teacher noted:

The current test-driven climate in education can make learning seem like a closed cycle of tasks. I want my students to see learning as a process of inquiry. This project allowed them to participate in scholarship in a more authentic way.

-TRG middle school teacher

Technology is seen as inherently more interesting than a textbook. Students at this age always feel that using technology is a more 'real world' experience and thus more relevant to their lives.

-TRG high school teacher

Creating Visual Space and a Virtual Museum Experience

While the Smithsonian Institution's museums host millions of visitors each year,[6] of this number, it is uncertain what fraction of the 49 million students who attend public schools in the United States are gaining access to the valuable resources Smithsonian makes available.[7] In focus group discussions with TRG teachers, they expressed a hope that digital learning resources can help reach those students who are unable to attend the physical museum in ways that the founders of the Smithsonian could never have imagined. They want their students to get a virtual taste of what it might be like to walk into one of the majestic galleries of the Smithsonian and stand in front of the actual object. This is consistent with the literature on the increasing popularity of virtual museum experiences and aligns with earlier Foresee results, which showed a minor interest in this area.

Suggestions included 3-D views of galleries and videos of docents or teachers speaking about artifacts.

I think certain exhibits lend themselves to this kind of 3-D visit. It would be a tremendous way to increase museum access to view via a SMARTBoard.

-TRG member

Coherence and Consistency

TRG lesson descriptions and reflections demonstrate how Smithsonian resources are often integrated into existing units or lesson plans to offer coherence and a multidisciplinary approach to the lesson. Several teachers began their lessons by awakening prior knowledge and context, then frontloading vocabulary needed for the resource lesson. This allowed teachers and students to seamlessly integrate the Smithsonian resource lesson into the existing schema for the topic.

Both the science and ELA aspects of this lesson were directly related to concepts students had been previously exposed to in class. We had class discussions and I front-loaded vocabulary and concepts so that students were more familiar with ideas involving the transition to upright walking.

- Special Education Teacher

[6] 2012 visitor numbers estimated at approximately 29 million according to www.newsdesk.si.edu

[7] NCES 2012 Statistics. Number of K-12 students attending public schools in 2010.

Text- vs. Non-Text-Based Learning

Comments cited earlier from previous teacher data regarding visual imaging and diverse learning styles are echoed in this group as well. TRG members who teach students with disabilities or students working below grade level seek out resources that provide non-text based learning experiences that are more accessible to multiple learning styles.

> *Students need to be taught with many modalities to address learning styles. Therefore, students that may be visual learners will grasp the insect lesson with images, students that are auditory learners will grasp the lesson as we listen to the insect sounds, students that may be kinesthetic learners will grasp the lesson as we build the insects.*
>
> -Kindergarten Teacher

To summarize, TRG members analyze the value of a resource based on the resource's ability to:

- 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
- offer personalization
- offer a virtual museum experience

How Do Teachers Keep, Use, and Share the Resources They Choose?

In examining the way that teachers extract resources from smithsonianeducation.org and other sites, we look at two things: 1) the usability and capability features of the site and 2) the habits and capabilities of the user. What does the site enable the user to do with the resource once they've determined that it's something they'd like to "keep"? Keeping a resource, or saving it in a place where it can easily be found again, is essential for the busy teacher. The TRG offered some new insights into how teachers intend to store, share, and use the resources they find.

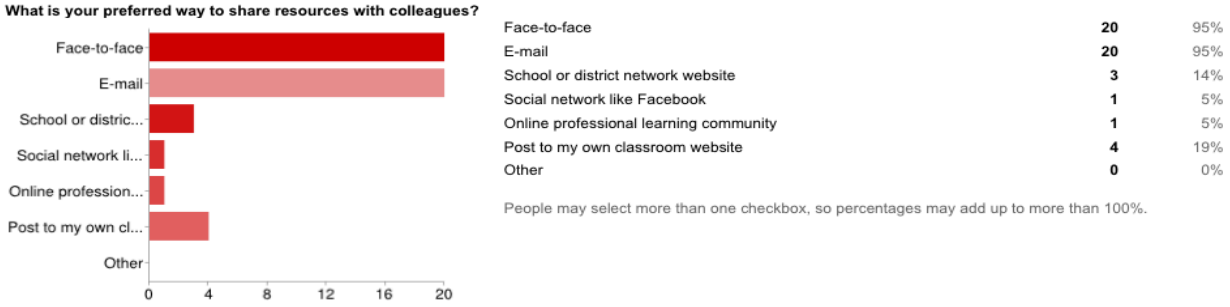
In a previous era, teachers had file cabinets full of lesson plans and ideas that they would pull out year after year. Today, teachers can bookmark, download, save, and print resources from sites with varying degrees of ease. Teachers in our research group state both in surveys and discussions that they want to share resources with their colleagues, but have differing opinions on how best to do this. There was consensus, however, that all TRG members wanted a way to save and download resources to a dedicated space.

The pre-survey of the TRG participants shows that teachers in this group use technology both for lesson planning and for student use during class, and that technology is more typically used for presentations or for viewing and sharing video or images. Practical issues come with extracting the resource, such as: What kind of technology platform will the teacher use to display the resource? Will it be used by students with individual laptops, iPads, or smartphones? Or, will the teacher project it onto a white board or SMART board, or a simple screen?

Sharing and Online Teacher Communities

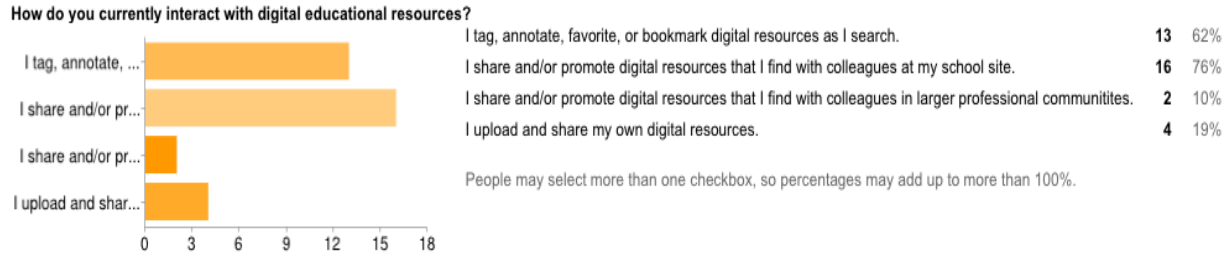
Our TRG findings suggest that teachers like to share digital information with colleagues, but that few (5%) belong to online educator communities, where they can make this a regular practice. More typically, 95% of teachers will email a resource or link to a colleague or tell them about it in person (see figure 9). Drawing conclusions from this finding is difficult, however. If teachers were given more opportunities to share online more easily, would they form different habits?[8]

Figure 9: Teacher Research Group Sharing Preferences[9]



Sixty-two percent (62%) of TRG members also indicated in the pre-survey that they typically tag, annotate, favorite, or bookmark resources they like, and 76% say they share resources with colleagues at their school site, but only two indicated that they share resources with larger professional communities (see figure 10).

Figure 10: Teacher Research Group Technology Practices



Despite mixed interest in sharing use-scenarios through social media, TRG members did express an interest in having a way to leverage platforms (such as Twitter, Facebook, and Evernote) integrated within the Smithsonian Education portal as a means to more readily consider documenting their activities and resource selections and sharing results with others. They also expressed an interest in having the ability to use Smithsonian Education on mobile data-enabled devices, such as smartphones or tablet devices.

[8] Several of our teachers mentioned that they tried to share a resource through Smithsonianeducation.org, but the function didn't work.

[9] Pre-survey

While most TRG users feel they were able to save resources from Smithsonian Education, some users noted in their annotations that they were not able to use this function. Beyond mere saving of a resource result, about half of users felt they were unable to annotate, comment, or share ideas about the resources on the Smithsonian Education site. This variable data on saving, annotating, and sharing resources suggests that these features are available, but were not easily found or used. As mentioned earlier, the users did appreciate these functions on other sites such as Gooru Learning and OER Commons.

Mobile Devices, Tablets and SMART Boards

The growing trend toward the use of mobile devices and the flexibility that digital tools now require as discussed in the literature, held true with the TRG as well. Discussions and observations reveal that TRG members accessing and extracting Smithsonian resources are not only using these items as merely pre-teaching reference materials but are also introducing them as in-class instructional items. Taking advantage of more options to actively display online content and resources in the classroom, teachers are projecting content via overhead digital projectors to simple screens or on interactive white boards for whole-group, teacher-led exploration. Additionally, some teachers have the discretion of providing online content directly to students individually or in small work-groups via laptops, iPads, tablets, or other individual user devices with the learners having more range in deciding how to consume information. With these new and evolving delivery opportunities, come new challenges as related to both access to the content on local networks and the use of the content in whole group vs. individual learning environments.

Classroom Use

TRG members surveyed in the beginning of the project revealed a variety of approaches to the use of technology in their classrooms (see figure 11). When describing how students engage with technology currently, the modalities were more limited. Most teachers (52%) said that their students use technology to communicate or present information or for skill enhancement. No one stated that, “Learning is transformed as my students propose, assess, and implement solutions to problems” (see figure 12). If we contrast this result with what our TRG actually did with their classes using digital resources as part of this project, we see a much different picture. Teachers did, indeed, transform their classrooms. Our preliminary findings suggest that not quite half (41%) of the TRG teachers want resources to come packaged with lesson plans, worksheets, quizzes, and comprehension monitoring components that will help them develop various types of learning exchanges/activities and assess if instructional goals were achieved (see figure 13). TRG teachers also consistently express the desire to download resources to their own space, to save resources for use in future units or related areas of study, to share resources with others, and to annotate or record ideas for how to use a resource in the classroom.

Figure 11; Teachers' Technology Use in the Classroom

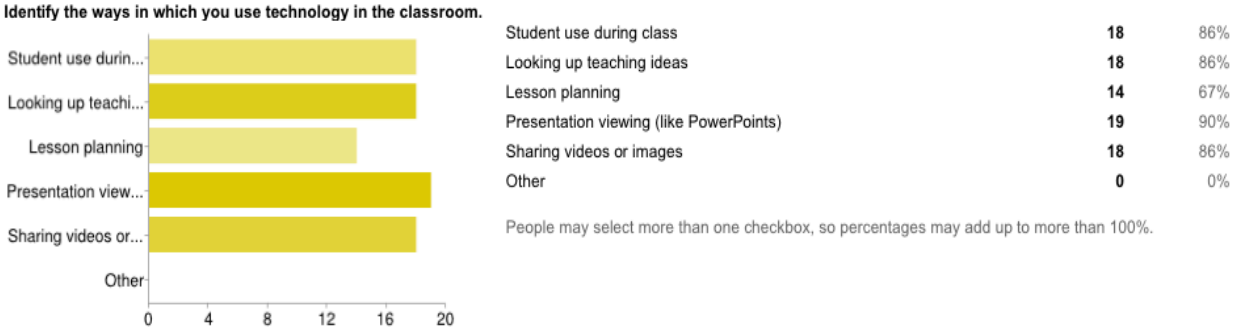
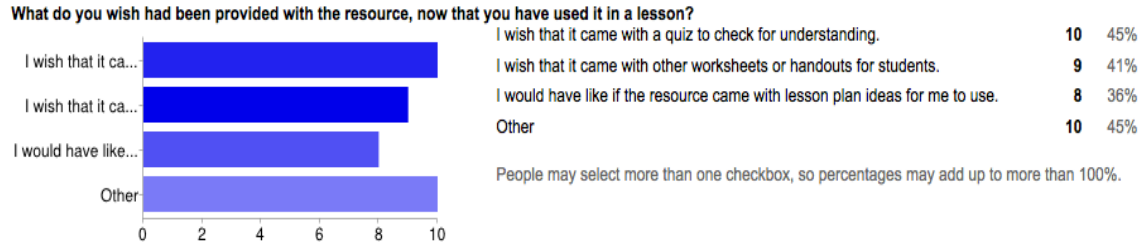


Figure 12: What do you wish you had been provided?[10]



Finally, in the teaching of their lessons and their discussion about their experiences, we get more detail about the steps teachers undertake when identifying, analyzing, and extracting digital resources from Smithsonianeducation.org and other sites and what tools and functions they value. A full description of each lesson developed, along with researcher annotations is attached as Appendix I.

The following example, from a sixth-grade teacher, provides a telling illustration of how this teacher augmented and adapted museum resources to meet the needs and learning levels of her students, as well as how she enhanced the content with both self-authored and other web resources to further engage students and make important learning connections. (See underlining for emphasis.) This teacher is representative of the TRG in her enthusiasm for the material and her willingness to experiment with a variety of resources.

[10] Post-survey responses

Sixth Grade Teacher

Resources used:
http://americanhistory.si.edu/collections/numismatics/corinth
http://americanhistory.si.edu/vote/patchwork.html
The project: Students identify different examples of Athenian and representative democracy, and identify similarities between American and Athenian democracy.

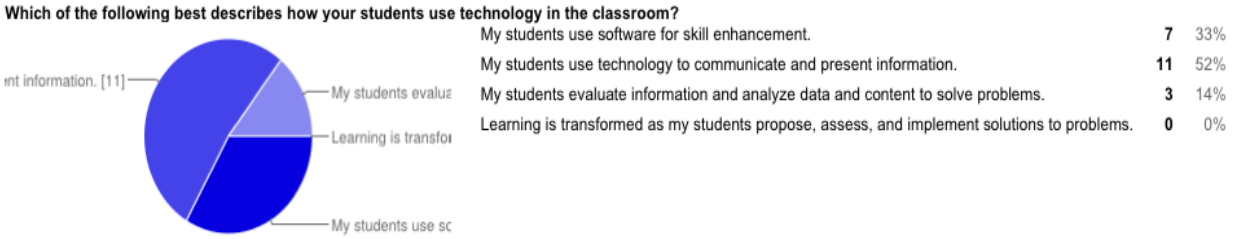
I used an activity with American coins to introduce the concept, and developed background information and vocabulary lessons into the PowerPoint to create context for the image. I used the Vote! The Machinery of Democracy Smithsonian site, as well as a video/discussion from TED. The visuals of the Smithsonian site definitely helped students make concrete connections to the ideas of direct and representative democracies, and I liked making it current by bringing in the TED video.

Issues/Challenges: I needed to really walk the kids through the Smithsonian site as the vocabulary is above their heads, and the set-up of the site is a little confusing. Even though the lesson is more teacher-directed than I would like, I will use it again as I really like the connections we were able to make between ancient history and current American politics!
When asked if they (the students) would have used the original source if asked to do research etc. they said they wouldn't because it was "boring" and they couldn't understand it.

When teachers reflected on their experiences building lessons with Smithsonian resources, the most consistent recommendations were for the provision of:

- 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

Figure 13: Student Technology Use in the Classroom



Conclusion

Our deeper look at teacher behaviors through the experiences of the Teacher Research Group served to confirm previous findings and expand our level of understanding. Where the user analytics and Foresee data showed us *what* teachers were looking for, we now know more about *why* teachers might choose a particular resource over another and *how* they might use it to build a lesson. We also have some concrete examples of lesson-building, promoting, and sharing tools that could be useful for prototype considerations.

The literature suggests that museums need to make resources more findable and to generate resources that are personalized and accessible anytime and 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

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 multidisciplinary opportunities
- support problem-based learning goals
- support standards-based teaching goals
- discover a virtual museum experience

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.

Prototype Implications

Determining the specific technical responses to these findings and making decisions about 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 team members along with resulting observations and data gathered from the TRG teams over the period of two months. This team determined that the initial prototypes should focus on some prescribed methods to enable more comprehensive search results and more access to metadata-enhanced promoting, sharing, and adapting tools in order to extend user activity beyond the Smithsonian web environment.

Search Tools

Teachers have moved from focusing on quantity of results to quality of results. While the relative value of securing many results still remains a commodity, teachers are interested in quickly sorting those results through the prescription of filters like standards, topic directories, and even feedback from other teachers. Methods to surface, identify, and aggregate 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 which does not fracture the stream of thinking of the consumer—and should provide multiple view options based on user preference. Additionally, better relational data—data that is more visible and that better integrates 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. This will provide a broader range of relevant resources for further filtering at the user's discretion.

Promoting and Sharing Tools

Teachers tended to be interested in the possibilities of idea sharing among educators. . Features that allow for this are nonexistent or limited or 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 might include an "opt-in"

push technology model that allows teachers to easily identify existing social communities and put out relevant activity updates across those communities as an integrated component for 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 for both classroom presentation and student interaction. Many resources have not been given such treatment because it would be time-consuming and knowledge-and-expertise intensive. . Therefore, teachers are increasingly interested in tools with which they themselves can 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 "offline," but that has gone largely unidentified and unharnessed. Teachers have become more 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. Consideration should be given to tools that allow educators to manipulate content elements and to add their own instructional activities. Further, educators should be allowed to sequence and share the resulting materials with colleagues as well as students. s.

Part B- Teacher Prototype Testing

Throughout the summer, Council for Chief State School Officers (CCSSO) "State Teachers of the Year" were in residence for weeklong digital learning workshops called "Mission Possible: The Model Classroom," sponsored by the Pearson Foundation.[11] Participants were largely K-12 classroom teachers. . The first two cohorts of teachers were State Teachers of the Year. The final cohort consisted of state teams of teachers and administrators nominated for participation by CCSSO. 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).

SCEMS researchers were given access to these teachers for one hour on four out of the five days of each weeklong session. The challenge was to design activities that could yield answers to important questions about teachers' needs and their use of digital resources, The researchers 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.

Prototype Testing Design and Methodology

The DLRP prototype testing regimens were designed around a two-round iteration of "introduce/use/reflect/analyze/synthesize/revise/re-introduce." This cycle was applied to the teachers' ability to perform micro-tasks associated with smaller prototyped components. Days

[11] See: http://www.newlearninginstitute.org/model-classroom-ccsso-teachers-year

one and two: discovery, annotation, enumerative analysis, and promotion. Day three: pedagogical development and publishing. Day four: a final round of generative "use/reflect/analyze" applied to the combined, comprehensive prototypes.

Each week there were three full iterations of a development-and-deployment methodology using the accelerated delivery of Agile software development. The researchers familiarized educators 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, the 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 resources for instructional delivery; and, finally, sharing work. The entire project team observed how the teachers interacted with the various elements to complete the given task. The observation team documented d the tendencies, behaviors, and eventual outcomes of the teachers using an annotation sheet (attached as Appendix J). After spending short periods of time interacting with the various micro-prototype elements, the teachers were given time and space to document their own findings (both as individuals and as members of small groups of two or three) by responding to a survey, which helped supplement the notation of the observers (attached as Appendix K). The week-one teachers also took a "pre-survey" to establish some baseline information. There was a debriefing at the end of each session to synthesize the information and pass it along to the full project team. The development team then worked rapidly to integrate these new ideas into the prototype, with clear programming and design tasks to be accomplished within 24 hours for redelivery to the teacher teams the next morning. Each week concluded with a timed exposure to a compilation of the micro-prototype elements as part of the more comprehensive full prototype solution. The compilation included revisions of feedback generated throughout the week.

The second week was conducted in much the same way as the first. The difference was that the micro-activities and prototypes had been re-informed by the first week's processes. At the conclusion of the second week, the team sought to analyze differences in feedback, use-trends, and modifications (if and where any existed) based on grade-level differences and relative teaching assignments. This allowed for divergent prototype features to be made available to week-three teacher teams for the final week of testing. It allowed, too, for the possibility that a single ubiquitous solution could be applied in order to diversify a common set of grade and subject-agnostic prototypes.

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

Figure 14: Phase 3 Teacher Sample by Grade and Subject Area[12]

Subject	Grade				
	K-5	6-8	9-12	All	Adults
All	12	2			
English/L.A.	3	4	5		

[12] Categories are not mutually exclusive.

History/Soc. Studies		5	6		
Science	2	4	1		
Eng. Language Development		1			
Special Ed.		1			
Physical Ed.		2			
Marketing Management			1		
Spanish			1		
Pre-Engineering			1		
Entertainment Technologies			1		
Business Ed.		1			
Math	1	1			
Computers				1	
Standards-based Education Consultant				1	
Art		1			
Profession Dev. Counselor	1				1
Math Specialist	1	1			
Gifted	1				

Figure 15: Phase 3 States Represented

Week One	Week Two	Week Three

Alabama	California (2)	California
California (3)	Illinois	Maine (6)
Indiana	Kentucky	West Virginia (9)
Kansas (3)	Michigan	Wisconsin (7)
Louisiana	Mississippi	
Minnesota (2)	Montana	
Mississippi (4)	Nevada	
Montana	New Hampshire (2)	
New Hampshire	Ohio (2)	
Pennsylvania	Oregon	
Texas	North Carolina	
Washington	Rhode Island	
Wyoming	South Carolina	
	U.S.Virgin Islands	

Research Questions

Three distinct groups of educators engaged in a series of activities, each of which was designed to surface answers to a series of guiding research questions:

Research Question 1 (applied all three weeks):
How do various related searches ranging from global to granular, render results within the prototype structure, and how are those results best consumed by the educators for classroom use?

Research Question 2 (applied all three weeks):
Once teachers find viable resources for use in the classroom, how do they choose to display and use those resources in the classroom?

Research Question 3 (applied all three weeks):
How readily can participants assemble their own unique collections and integrate instructional interactive modules?

Research Question 4: (Applied *only* in week three)
If given tools to include Common Core standards and external web resources, will teachers feel confident in analyzing and identifying appropriate additional resources and standards as correlated to Smithsonian resources?

Research Activities

Each week, the research team was presented with a different cohort of teachers. As mentioned above, modifications were made each week to the prototype as well as to the

activities, depending on the grade and subject areas represented, the revised goals, or the feedback from previous participants. The activities incorporated the use of other sites highlighted in the environmental scan, as well as tasks with SCEMS's 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 in order 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 Summer Institute attendees' Facebook page. Survey data were quantified and charted. As a final step, findings were triangulated with previous weeks' findings, then cross-referenced to frameworks and previous data. A findings report, incorporating charts, graphs, and matrices, as well as discussion points, was issued and discussed after each week. Findings reports are included as Appendix L, M, and N.

Analysis

As in the previous phase of investigation with California teachers, the research team employed a combination of heuristic, quantitative, and qualitative measures. The team used surveys, observation and reflection to capture a range of interactions and information. [13] Synthesizing these data and findings required a complex set of careful analyses. Observation annotation notes were culled at the end of each day and analyzed for patterns of behavior using traditional coding and count methods. These patterns were then quantified and recorded. The research team also met after each session to discuss their observations and triangulate findings and check for inter-rater reliability. 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. Survey data were quantified and charted. As a final step, findings were triangulated with previous weeks' findings, then cross-referenced to frameworks and previous data. Analysis and iterative revisions to the prototype focused on methodologies, processes, and design choices to assist with search and discovery, selection of resources for saving and organizing, degrees of data exposure and augmentation, and proposed instructional delivery formatting and scaffolding.

The Prototype

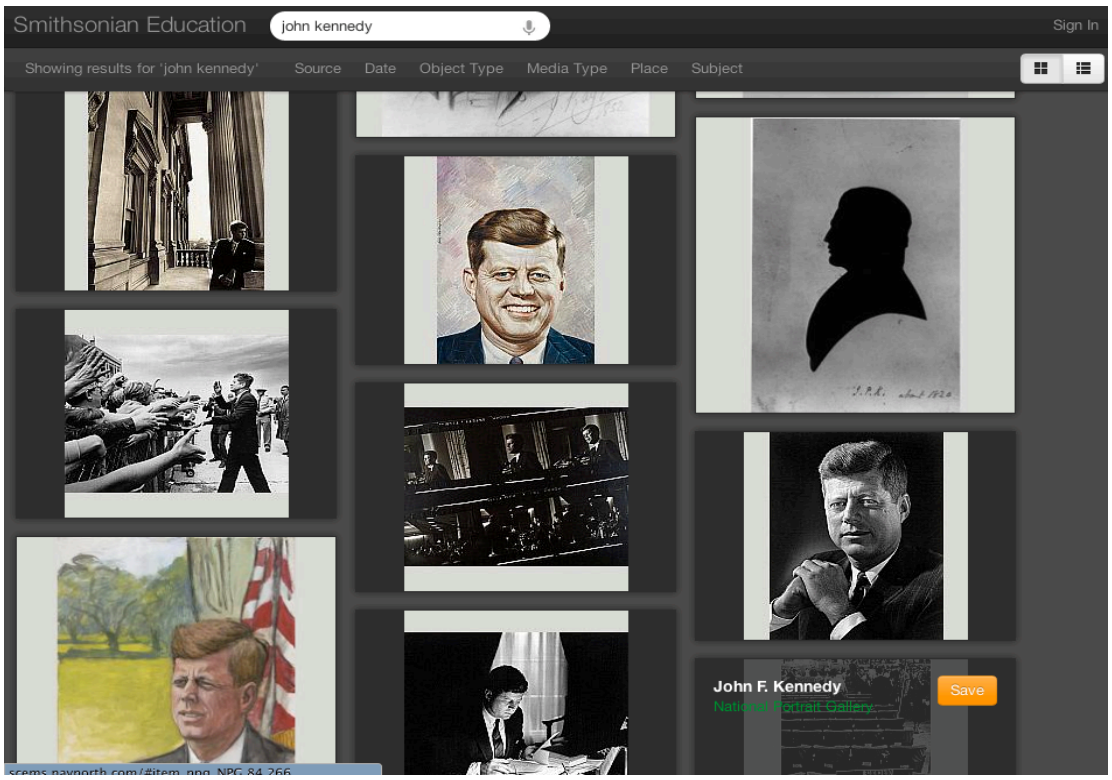
With these constructs in mind, engineers and researchers elected to begin by directing the educators to a compilation of paper-based interface activities and existing web resource sites for confirmation of some basic structures in which to create a full prototype. The developers worked quickly to create a web environment with a functional user interface (UI) and a set of search/save/organize/adaptat tools tied directly to the existing Smithsonian database of digitized assets and metadata profiles. Full access to the prototype is available at http://scems.navnorth.com

[13] See Leftwich & Bazley (2009) *Pedagogy and Design: Understanding Teacher Use of Online Museum Resources*. Museum and the Web Conference 2009.

Search and Visualization Tools

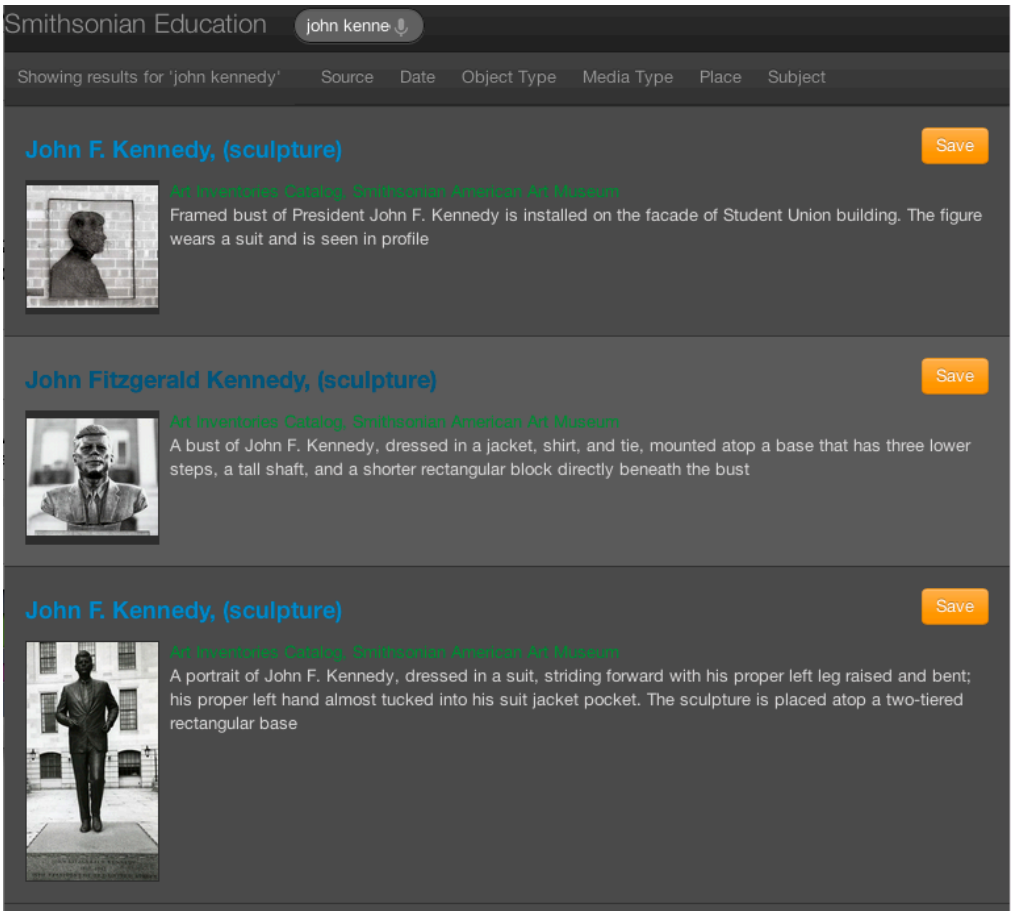
The prototype design incorporates a simple search interface that surfaced content not only from the SCEMS collection, but also from the larger Smithsonian Collections database. The default visual display, created on the basis of research findings, combines images of the collections, and commands the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

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 so that neither search methodology is abandoned. It allows the methodologies 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) that 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 provide users with these advanced search-and-discovery features without requiring the users to authenticate via an account log-in 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 or resources 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 log-in, users can comment on a resource or collection they have created. They can share the resource through email, "pin it" to a Pinterest account, or push it out through Facebook or Twitter. They can annotate it 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, 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 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 standards and suggest matches for the resources and activities they developed as part of their collections.

Image 3: Prototype Tool for Adding Resources to Collection

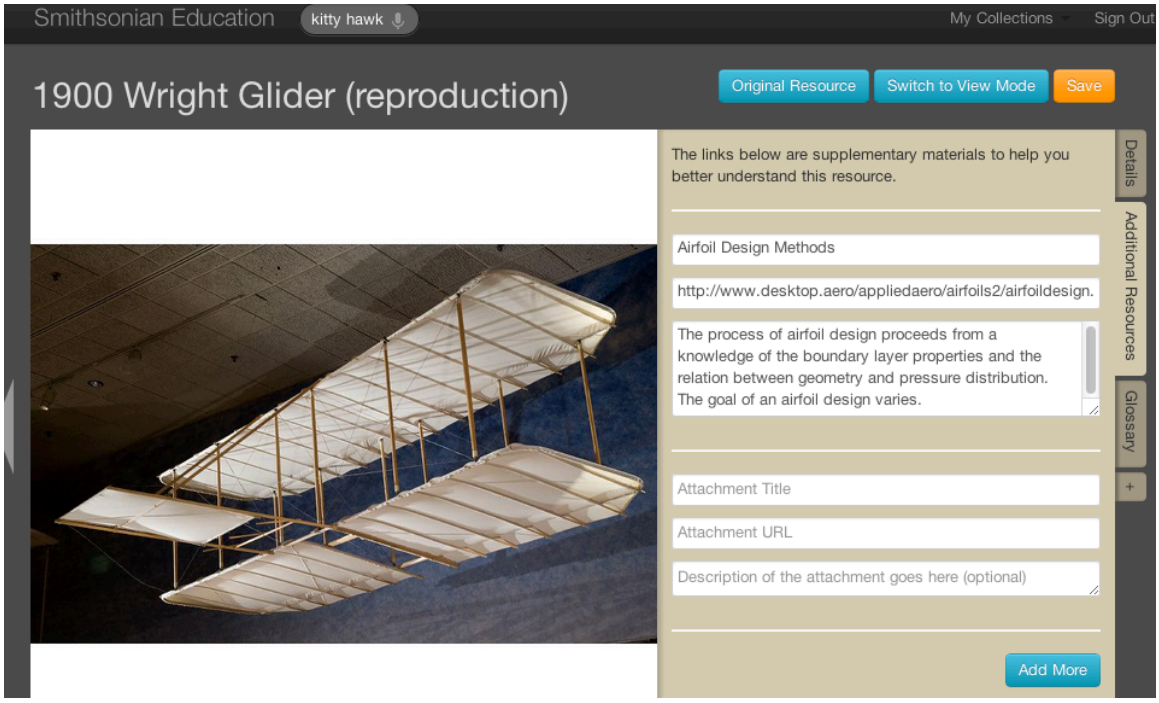


Image 4: Prototype Google Map Tool

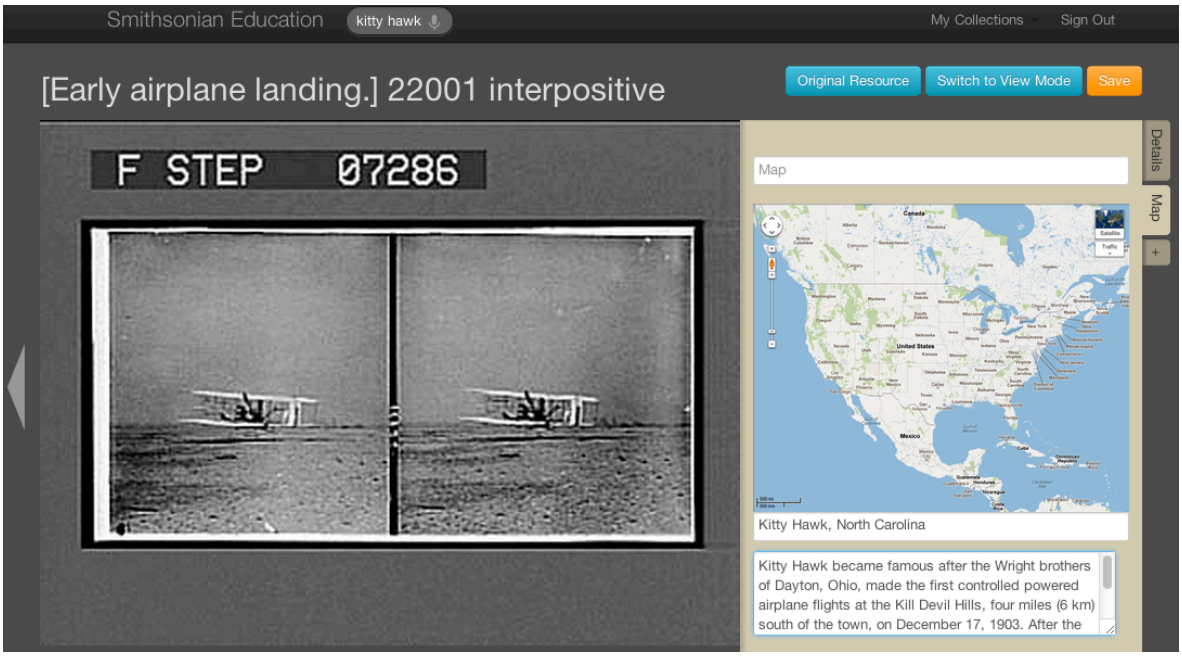
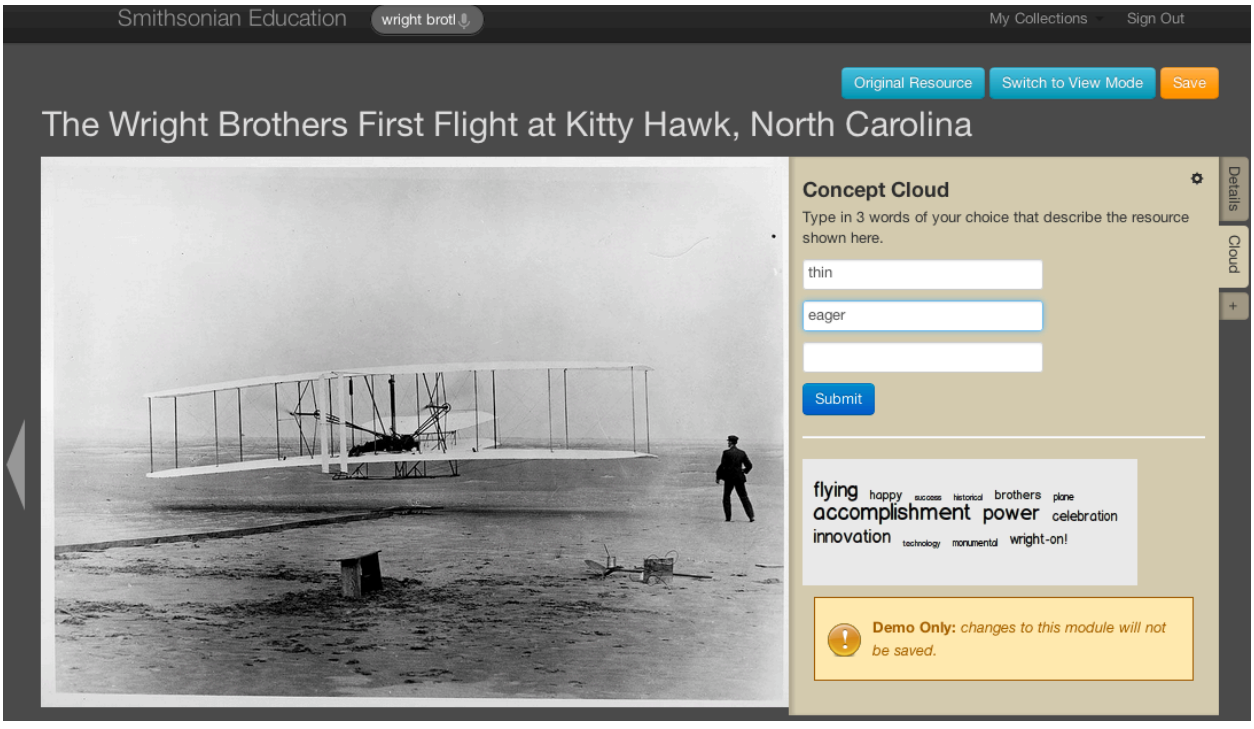


Image 5: Prototype Concept Cloud Tool



These identified interactive elements within the prototype (above) were rendered operational or semi-operational 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

While there were similar activities in all three weeks, each week presented researchers with different issues due to the grade level and subject theme for that particular group. In addition, the prototype was adjusted each week as part of the iterative design process. Despite this variability, the prototype testing process did serve to confirm previous findings and provide valuable insights into further toolset development. We provide here a brief overview of the findings for each week, organized by research question where applicable.

Week One Prototype Testing

In the first week of workshops, the team worked with 20 participants, who were primarily K-5 teachers with a multidisciplinary background. The theme of the week was "Nature and Animals."

Search Methods

What search features, filter features, and return views do teachers prefer to use when identifying and analyzing Smithsonian related resources? And (for the final search using the prototype): 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 in the classroom?

Participants were asked to identify three terms to search for in each of three websites: www.smithsonianeducation.org, www.collections.si.edu, and http://scems.navnorth.com. They were then observed as they utilized varying searching, saving, and sharing strategies. In each of the search environments, 16 or more of the participants elected to search by entering a search term to query initial results. Where gallery view was provided and found, most of the participants switched to that view option for results. While the focus of the exchange was to note the methods by which users searched and elected to review and analyze their results, many teachers naturally saw the process as less of a testing regimen than as an actual search in which they hoped to find good instructional resources. Because the data being accessed from the Smithsonian's Collection Search Center is not necessarily structured to produce resulting assets tailored for the classroom or for teachers, many found the varied results a limiting factor to their experience.

In the prototype specifically, there is a need for richer metadata describing the "vibrancy" of each item as opposed to a litany of curation notes, holdings data, etc. This was not the intent of the metadata in place; however, in some instances, there were quality contextual descriptions of the item in question that were presented in a way that helped narrate the item's relevance as an artifact to teachers. In other instances, the descriptions were not provided in that same context; however, the teachers had seen the actual item on display and were curious to know why the actual placard data that accompanied the actual items on display in the museum (which they found useful) were not part of this digital collection data.

Saving Methods

Do participants value repository agencies enabling the combination of their resource collections with central instructional tools in order to capture the instructional development and

modification process internally within the site—that is, where the development previously occurred outside the site?

Participants actively looked for ways to save their resources within the site they were using. In particular, when the ability to save to a collection was available, participants used it. A concern raised by many users involved the ability to access saved resources later (Smithsonian Collections allows you to save, but only for that computer on that visit); only the prototype site allowed participants to sign in to an account for future access. Regardless, some were confused by how to find the collections that they had built once they left the site.

If the site did not afford opportunities for saving, participants were observed downloading the resource or copying and pasting the link to their computer desktop at a single table of five teachers (3 of 5). (One participant noted that she liked PDF resources because they could be archived on her laptop and be used again without having to revisit the website.)

One request made by many participants was a means of quickly saving resources as they search. They said that they would later like to refine their results and even organize them into categories such as grade, subject, or unit (e.g., "Fifth Grade, Social Studies, American Revolution").

Sharing Strategies

Participants used any tool available on the site to share the resources they found with colleagues, regardless of past practice. For example, many used the "Facebook Share" option, even though they do not typically use Facebook to share educational resources (per their feedback). Other sharing methods included emailing the link to their own addresses or to a colleague (the most popular method); uploading the link to a personal or school wiki; "tweeting" it to their Twitter account (1 of 5); adding it to the Reading List on their iPad (1 of 5); or "bookmarking" it using a website like Diigo or Pinterest (3 of 5).[14]

Organizing Strategies

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

In the first week of testing, a limited number of participants moved through to a point of assembling a collection within the prototype. The six who did manage to create collections felt it critical that teachers be allowed to aggregate their own items according to how they saw the items assembled for classroom use, independent of collection groupings on the Smithsonian sites.

While direct testing and observations were not conducted in the first week to a large degree around organizing resources from the Collections Search Center database, teachers were given a demonstration of the general methods that would be deployed in the following weeks. Teachers favored being able to further edit the title and description of the resource to create more student-accessible contexts for the items that would be saved as part of a personal collection.

[14] Counts taken from a single group where moderator kept numerical track of sharing methods, other observers confirmed similar trends at their stations.

Presenting and Teaching Strategies

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?

Participants each arranged four to five paper screenshots of various Smithsonian sites onto a poster board to create a "viewing gallery" for presenting the sites to students, as a class or individually. (See *Teacher Posters of Viewing Gallery Week 1* - Appendix O.) Researchers observed teachers while making the posters and asked them specific questions about their thought processes as they were working.

About half of teachers (47%) created a viewing gallery that "stacked" the sites (one site viewable with others hidden or partially hidden) and relied on the teacher to pre-select the sites to be viewed by students. The participants who envisioned projecting the screen up in front of students and interacting with the sites as a class preferred this style. Many of the posters also revealed a bias toward using tools that they currently use for saving resources, including folders and binders.

Four of the teachers created a gallery that allowed students to choose the order and showed all the sites without giving preference to one site over another. These were often creative in implementation, using such devices as a rotational "geometric shape" and a "virtual museum gallery." This style was associated with activities in which individual students used the sites to complete a project.

Assembling for Instructional Interactive Delivery as part of "Learning Gallery"

Participants were given time to explore the National Archives site "Docs Teach" as preparation for work with the prototype. Participants then began exploration of the prototype and attempted to identify and connect instructional interactive items to resources assembled in their own collections.

The testing of interactive modules in the prototype proved more frustrating for participants (due to the semi-operational status of some functions) than "playing" with the fully developed tools available on DocsTeach. They found this experience very exciting and provided researchers with further insights into what features to consider for the eventual toolset. The most frequently cited issues or questions that arose when using these aspects of the prototype were:

- Can the interactive modules be saved apart from the resource?
- The prototype didn't work with Firefox.
- There was not a clear difference between what the student sees and what the teacher sees.
- And finally, the + tab that opens up the interactives palette is not obvious enough to users (only two participants found it without prompting from staff or other teachers).

Online Sources

Teachers were asked in a survey about the sites they use to find educational resources and where they go online to connect and collaborate with other educators.. The teachers use a variety of online repositories to collect teaching resources (27 separate sites were listed). The highest frequency rate of any one site listed was three times (for National Geographic and Read, Write,

Think). Teachers listed 15 different sites that they visit for online collaboration. The highest frequency rate for these sites was five (for Pinterest and Facebook). Five teachers also listed email as their preferred place for collaboration. Responses were charted by education source, non-educational source, and educational focus vs. community focus (see Appendix L). Researchers conclude that in seeking content, 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 that they use both education and non-education sites equally.

Summary of Findings for Week One

1. Teachers prefer to search by entering a general search term, then filtering further if needed. Most teachers also preferred the gallery view to review their search results.

2. Teachers want to save resources that they find useful and will employ whatever means available to them to do it, even if the site does not provide this function.

3. 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.

4. Teachers want the flexibility to organize and annotate resources according to their own schemas. These findings are limited, given the small number of teachers (six) who went on to assemble a collection with the prototype.

5. Teachers 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).

6. Participants were excited by the interactive modules that utilized the resources found in the Smithsonian collection. After exploring the possibilities available in DocsTeach, as well as the prototype, participants expressed an interest in a variety of tools.

7. 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 that they use both education and non-education sites equally.

Week Two Prototype Testing

In this week of workshops, the team worked with 24 participants for one hour over the course of four days. Participants were mainly high school teachers in the humanities. The Summer Institute theme for the week was "Community/Civic Engagement and American History."

Search Methods

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

Participants were asked to identify three terms to search for within the prototype http://scems.navnorth.com. Participants were then observed as they utilized varying searching, saving, and sharing strategies, including creating collections of resources.

Like the previous week, most began with general search terms and filtered from there. Observers noted that filter tabs were difficult to locate for most participants. Once they did find the filtering tabs, 13 out of 15 participants were observed to use filters to narrow their search results. However, many expressed a desire to be able to select more than one filter per category at a time. They also added that the terminology was not teacher-friendly. Some suggested filtering terms included by date, era, style of art, and geographic location. As in the previous week, over half of the participants preferred the gallery view for displaying their search results.

Unlike the previous group, these participants also expressed an interest in having more "intelligence" in the searching process. For example, for searches that elicit zero results, a suggestion of related terms would be helpful. If a term is misspelled, particularly by a student, the search bar could prompt the user with correct spellings. Participants would also like resources that are tagged with similar metadata to surface as other suggested resources. Finally, as new searches are created, participants would like prior search terms to be "remembered" either as a list or to help further narrow results.

They often expressed a wish for more information to assess the value of a resource. Suggestions included teacher reviews or ratings; the most popular resources surfacing at the top of a search; and more background information included with the resources (such as that which is found next to an object in the museum). Cross-pollination with other federal agencies, such as the Library of Congress and National Archives, was requested as well.

Participants also suggested the ability to search by student end-product and then apply tags to indicate which Smithsonian resource was used in the development of the lesson and product.
Finally, many wanted a simple title to be included with images to help them quickly identify which resources might be useful (rather than having to scroll to see this information).

Sharing Methods

Participants shared concerns about their schools' or districts' blocking tools for sites such as Facebook and would like alternate means to share, such as a URL of the a resource or collection, or the ability to share in the Smithsonian online community.

Presenting and Teaching Strategies

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?

Each participant arranged four to five paper screenshots of various Smithsonian sites on a poster board to create a "viewing gallery" for presenting the sites to students, as a class or individually. (See *"Teacher Posters of Viewing Gallery Week 2*" - Appendix P). Researchers observed teachers while making the posters and asked them specific questions about their thought processes as they were working.

Most participants created posters showing a "gallery-type" view (rather than a "stacked" view) where a site is clicked to expand and clicked again to return to the gallery view. Participants were split on whether to have the site order directed by teacher or student. There might be some advantage in having two ways to view (teacher view or student/class view).

Organizing Strategies

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

Participants continued to search and save resources to collections. They then explored the "interactive modules tool" within the prototype. All teachers placed chosen resources into a collection, and most of them went on to create and name two to three additional collections. The issues that arose mostly had to do with the environment of the prototype:

- Many participants had difficulty navigating from the expanded view of a resource back to their original collections page.
- When selecting and viewing a single resource, there was confusion in the use of the "back" button. Several participants stated that they would prefer a "close" or "x" button to return to the collections page.
- Once resources were in a collection, participants wanted a simple title to be included with the thumbnail image to help them remember the resource.

Participants were very excited to utilize the interactive modules tool once they found the tab, but requested that it be easier to find (only one-third found the interactive modules tool AND clicked on it). Several suggested that the user have the ability to use the tool as soon as the resource is saved, rather than having to save it to a collection first and then open the resource within the collection to use it.

Many of the teachers were not comfortable "playing around" with the buttons and opted to ask an observer what an object did rather than click on the object themselves. One participant was observed to scroll over an editable text field but didn't stop to add any text until an observer prompted them. A few teachers needed an explanation of the interactive modules (what a "concept cloud" is, for example).

Participants in this group (mostly high school teachers) expressed the need to have students using the site as much as, or even more than, the teacher. They would like the ability to share tools with the class and have students be able to easily transmit their work resulting from the interactive modules back to the teacher.

Some additional interactive modules requested by teachers included:

- A slideshow of resources

- Compare and Contrast tool that allows teachers to position two separate digital items side by side (whether art pieces, pictures, or articles on a common topic with different perspectives)
- A virtual tour where students can find/select/study exhibits

Summary of Findings for Week Two

1. Teachers show similar search methods and viewing preferences (gallery view) to previous group.

2. Participants want more intelligence in their searches and results to guide them toward the most valuable resources. Intelligence included: auto-complete typing, auto-correct spelling, and similar items offered as suggestions in returns that bear few results.

3. Teachers need 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).

4. Participants in this group desire the ability to have students use the site and its tools as much as the teacher.

5. Participants appreciated the search functionality of the site but want better visibility of the tools, including prompts and explanations for their use.

6. Participants want the ability to easily share resources or even collections with other teachers and even their students, but have concerns about school or district restrictions.

Week Three Prototype Testing

In the final week, the team worked with 25 participants for at least an hour on three separate days. The theme for the week was "Science and Innovation." Although it was identified as a week targeting teachers of fifth through ninth grades, participants were largely middle through high school teachers across a diversity of subject areas. (Indeed, three were not classroom teachers, but professional development coordinators or state-level education office specialists.) This week, researchers added a new question regarding the use of external resources and Common Core standards.

Searching Methods

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

Participants were asked to search for, identify, and save at least three resources that could complement their Mission Possible curriculum project. They were then asked to create a custom

collection of those resources that they could present to their students or give to their students for individual exploration.

Most participants focused on the use of a search box without signing in or attempting to create account. Many participants found that search results rendered in a gallery-type view as default was preferable for viewing large returns. Three observers did take occasion to mention the alternative list view option to their respective teacher groups. Based on the annotation data, approximately six of 23 educators opted to switch to list view.

A majority of participants within each observation group were able to generate considerable returns on their queries within the prototype. Some typical comments focused on the occasional odd result string, such as the search term "civil war uniform" returning an inordinate amount of images of war-memorial statues, or the search term "women aviators" returning Ivory soap ads. They often desired more information to assess the value of a resource, and were not satisfied with the amount of metadata rendered across the image upon cursor float-over. Approximately eight of the teachers inquired about methods that could better help students analyze results upon performing searches with the prototype tools.

Based on observer notes, approximately eight to ten teachers actually used a filter to narrow down resulting returns. When others were shown the filters, the numbers of those using them primarily tried to filter their results to include only images, and were less clear on the other designators, such as electronic resource or collection description.

When most teachers wanted to improve or narrow their results, they amended their search terms to render more specific results.

Additional Resource Tool and Common Core Standards

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

Participants were asked to identify and upload/add at least one external web resource that teachers thought would enrich the collection(s) they had developed. They were then asked to assign appropriate Common Core standards as related to the collection and the type of instructional activities that the teachers anticipated developing to help students demonstrate the learning achieved through interaction with this collection.

Given that teachers were exposed to sample collections in advance and to a method by which they could integrate additional, external web resources, there were more requests for items like resource tags, for better and more coherent integration with external web assets, and for the inclusion of topical directories to organize relevant collections. Because participants had difficulty locating the Common Core tab, this exercise did not surface enough data to be useful. In the post-survey, however, participants were asked the question: *How much of next year's curriculum is already aligned to Common Core standards for your classroom?* Almost half of the teachers estimated the percentage of aligned curricula at 75% or more. Researchers conclude that providing Common Core standards as a search filter remains important.

Sharing Strategies

Teachers were not run through a precise sharing exercise this week, but were directed to look for ways in which to share their collections if they so desired. Three observers noticed educators trying to utilize the community dissemination tools layered throughout the prototype, like those found in the upper right hand corner above collections. Approximately seven teachers attempted but failed to share to Facebook or tweet or add their collections to Pinterest when clicking on those placeholder buttons. In ensuing conversation, many teachers indicated that they would like a simple means to post links to specific collections they've developed to other sites such as Edmodo, Schoology, or their own teacher sites.

Organizing Strategies

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

Despite some initial bugs that obscured various organization tools in Windows 7 and older versions of Firefox on some laptops, teachers were readily able to create collections when presented with a fully functioning prototype. Teachers quickly asked for access to advanced functions such as creating subordinate lists for a given collection or generating collections on the fly during a search phase without losing their search screen. Approximately 19 of the 23 teachers produced multiple collections, but many struggled to know how to easily navigate across those collections and get back to search options fluidly.

Presenting & Teaching Strategies

Eleven of the 23 participating educators found and utilized the interactive modules as part of their collections prior to being directed to do so during an activity. Once the interactive modules were identified and a context given for their existence, all educators utilized one or more of the tools. The numbers of teachers using the interactive modules in at least one instance within their primary collection are as follows (teachers could select more than one):

- Discussion Tool = 20 users
- Concept Cloud Tool = 16 users
- Mapping Tool = 15 users
- Notes Tool = 13 users
- Additional Resource Tool = 12 users
- Quiz Tool = 11
- Crossword Tool = 10
- Glossary Tool = 10

Some additional interactive modules requested by teachers included:

- Audio Files
- Compare and Contrast tool that allows teachers to position two separate digital items side by side (whether art pieces, pictures, or articles on a common topic with different perspectives)
- Wiki Space
- Digital Graphic Organizer with excerpts or images from resources
- Image Editing Tool

- Simulations of the Museum Gallery Space associated with items

Summary of Findings for Week Three

1. This group employed similar methods of searching as previous groups. However, the group did not
   make use of filters to any significant degree, preferring simply to modify search terms. The majority of participants in this group also preferred the gallery view.

2. Teachers like to be able to upload resources from other sources to augment their collections, and they appreciate being given tools that make this easier to accomplish within the site. Most participates teach with curriculum that is aligned, or close-to-aligned with Common Core standards.

3. Participants made full use of existing tools, but suggested a number of advanced interactive modules.

4. Participants want better search results and ways to modify descriptions for student search and analysis options.

5. Participants are looking for more intuitive design and flow between tools and facets of the prototype.

Cumulative Prototype Testing Findings

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

If we use the lens of the project goal of identifying, analyzing, and extracting content for more creative classroom use, 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. They also prefer the gallery view to review their search results. The workshop participants want more intelligence in their searches and results to guide them toward the most valuable resources. This "intelligence" includes auto-complete typing, auto-correct spelling, and similar items..
- 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, the researchers have concluded, the teachers 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, and will employ any available mains to do this, 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 (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).
- the ability to have students use the site and its tools as much as the teacher.
- content that is aligned, or close-to-aligned, with Common Core standards.

When extracting content to create an interactive lesson, teachers want:

- the use of interactive modules with the resources found in the Smithsonian collection.
- a variety of tools.
- better visibility of the tools, including prompts and explanations for their use.
- the ability to upload resources from other sources to augment their collections (they appreciate tools that make this easier to accomplish within the site.
- more intuitive design and flow between tools and facets of the prototype.

Ultimately, these findings were applied to 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 16. Technical requirement specifications for these features are presented in DLRP's Volume IV, *Technical Specifications Document*.

Figure 16: Summative Chart of Phase 3 Prototype Modifications

I/A/E Elements↓	**Modification Suggestions for Next Round of Testing**	Increase Skills	Increase Creativity	Active Creators
Identifying ↓	**Week 1**			
	Provide more comprehensive metadata associated with digital items/assets where that metadata exists.	X		
	Mimic or mock-up a more comprehensive front end for users initiating a search, in order to obviate confusion about the use of a partially developed prototype.	X		
	Create prompts for yet-to-be developed items that indicate upcoming features and/or prompt users for feedback.	X		
	Clarify actionable terms like "curate" (change to avoid confusion with related	X		

I/A/E Elements↓	Modification Suggestions for Next Round of Testing	Increase Skills	Increase Creativity	Active Creators
	processes associated with this term, like "save") functions like Save and Go Back. Add to collection, create collection, and "flatten" transition process for selecting items. Add the ability to move into collection without expanded view modal screen, or collapsing collection item view into expanded modal view.			
	Week 2			
	Use more common teacher terminology and student-centered language in describing items and tools.	X		
	Create a list of existing search terms correlated to teacher-centered subject lists for accessing resources.	X		
	Consolidate all Smithsonian assets from various units/collections behind a single point of entry and set of search tools for educators on the education site.	X		
	Clear filters for each new search.	X		
	Week 3			
	Create directories of resources as tied to Common Core Standards.	X		
	Create directories of resources developed by other educators.	X		
	Create subdirectories or subordinate descriptors based on rigor and relevance levels.	X		
Analyzing↓	**Week 1**			
	Provide clear entry-point and corresponding terminology for the instructional modification options for a given resource item within a collection.	X		
	Create more semi-functional instructional modification options for the user to try.			X
	Include an "easy-to-read" visual of each interactive instructional tool in addition to a teacher-centered description.	X		
	Consider proximity of instructional tools to resource items, and perhaps provide resizing options for teacher control of the space.		X	
	Week 2			
	Allow teachers to correlate			X

I/A/E Elements↓	Modification Suggestions for Next Round of Testing	Increase Skills	Increase Creativity	Active Creators
	collections/activities to sample question items from end-of-year state assessments focused on higher-order thinking skills.			
	Allow teachers to develop resource considerations in the context of a full lesson plan to better frame resource selections and sequence.			X
	Week 3			
	More compare-and-contrast tools and better conceptual diagramming features for students to organize information and inferences			X
	Interactive modules to help teachers stimulate instructional thinking and approaches when new tools/aids are suggested by system or other teachers			X
Extracting↓	**Week 1**			
	Collections can be saved and retrieved at later point with user authentication	X		
	Collections can be modified beyond point of original creation	X		
	Collections can be shared via traditional means such as email and download	X		
	Collections can be shared via digital communities in which a teacher already participates	X		
	Collection can be displayed for classroom implementation (eventually rearranged according to teacher demonstration preferences)			X
	Week 2			
	Push resulting student work/entries on quiz interactives to spreadsheet or publish to third-party learner community site like Edmodo.			X
	Allow teachers to highlight sections of web resource and embed information or question bubbles, which students can then click on in order to engage or respond.			X
	Add chat feature for teacher and students			
	Provide library of open-license audio files (songs, sound effects, etc.) that teachers can load to a collection. Students can select which should accompany their own		X	X

I/A/E Elements↓	Modification Suggestions for Next Round of Testing	Increase Skills	Increase Creativity	Active Creators
	collections.			
	Provide teachers a final "publish" button or check box that allows them to determine when something is ultimately shared or unshared to students.	X		
	Provide a space for students or teachers to draw responses to resources.			X
	Timeline tool that allows a teacher or student to lay out resources and corresponding information chronologically.			X
	Consider multiple options for student work to transmit to teacher (beyond email).	X		
	Week 3			
	Offer method of "downloading" ready-to-use collections with embedded activities, but then "uploading" modifications made to those materials.			X
	Blend the activity/interactive tools into the resources by suggesting certain tools for certain types of resources. This would expedite the research and application process during lesson planning and lesson design.		X	

Conclusion and Recommendations

As we have detailed here, much was learned in this process, and much that was already known was confirmed. Most importantly, however, the Digital Learning Resources Project (DLRP) revealed to researchers, in very specific ways, what the next generation digital toolset for Smithsonianeducation.org will do. It showed, too, how the carefully conceived prototypes, if developed, can help teachers to more effectively identify, analyze, and extract specific Smithsonian digital learning content, making strategic use of digital media and visual displays of data .

Moving Forward

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 required by all units making use of common tools and accessing common data and repositories .It is, however, 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 lead to more sophisticated tool development.

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

According to this vision, SCEMS can provide the technical means for teachers to broadcast user-generated content and data across the various online educator communities and social networks, expanding its impact and presence in the digital world.

References

Al-Khalifa, H. & Davis, C. (2006). Measuring the Semantic Value of Folksonomies. *Innovations in Information Technology Conference*. doi :10.1109/INNOVATIONS.2006.301880

FolksAnnotation: A Semantic Metadata Tool for Annotating Learning Resources Using Folksonomies and Domain Ontologies. *Innovations in Information Technology Conference*. doi: 10.1109/INNOVATIONS.2006.301927

An, Y.-J. & C. Reigeluth (2011-12). Creating Technology-Enhanced, Learner Centered Classrooms: K-12 Teachers' Beliefs, Perceptions, Barriers, and Support Needs. *Journal of Digital Learning in Teacher Education* 28(2): 54-62.

Anastasiou, D. & Gupta, R. Comparison of Crowdsourcing Translation with Machine Translation, *Journal of Information Science*, December 2011 37: 637-659

Barker, Phil (2005). What is IEEE Learning Object Metadata /IMS Learning Resource Metadata? *CETIS Guide. Joint Information Systems Committee (JISC),* University of Bolton, United Kingdom.

Bearman, D. & Trant, J. (2010). On Being Social. *Museums and the Web Conference 2010 International Conference,* Toronto: Archives & Museum Informatics: 3.

Beasley, S. & Conway, A. (2012). Digital Media In Everyday Life. Museum of Science and Industry, Chicago, Ill. *Museums and the Web Conference 2012*.

Bebell, D. & Kay, R. (2010). One to One Computing: A Summary of the Quantitative Results from the Berkshire Wireless Learning Initiative. *Journal of Technology, Learning and Assessment*, 9(2), January

Bloom, B. S., M. D. Engelhart, et al. (1956). Taxonomy of Education Objectives. *Cognitive Domain,* New York: Longmans Handbook 1.

Borun, M. (2005). Evaluating Museum Exhibits and Online Programs in *Proceedings of Web Designs for Interactive Learning Conference, Website evaluation* (pp. 2-11) Ithaca, NY: Cornell Lab of Ornithology and The Exploratorium. http://www.rockman.com/publications/articles/Assessing_the_Outcomes.pdf

Borun, M., Schaller, D. M. Chambers & S. Allison-Bunnell (2010). Implications of Learning Style, Age Group, and Gender for Developing Online Learning Activities, *Visitor Studies Association*, 13:2, 145-159

Boyang L., Appling, D., S. Lee-Urban & M. Riedl (2011). Learning Sociocultural Knowledge via Crowd sourced Examples. Association for the Advancement of Artificial Intelligence (www.aaai.org).http://www.cc.gatech.edu/~riedl/pubs/hcomp12.pdf

Buffington, M. (2007). *How do Teachers and Students Use Museum Websites?* Talk presented at the American Association of Museums Annual Meeting, Chicago, IL.

Bull, G., Thompson, A., Searson, M., Garofalo, J., Park, J., Young, C., & Lee, J (2008). Connecting Informal and Formal learning: Experiences in the age of participatory media. *Contemporary Issues in Technology and Teacher Education*, 8(2). Retrieved from http://www.citejournal.org/vol8/iss2/editorial/article1.cfm

Chao, J. T., Parker, K. R., & Fontana, A. (2011). Developing an interactive social media based learning environment. *Issues in Informing Science and Information Technology*, 8(Navigating Information Challenges), 323-334.

Clari, M., Graham, P. (2012). Learning To Let Go: Changing Patterns of Participation and Learning through the Digital Collections of the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS). *Museums and the Web Conference 2012.*

Coffey, A. and P. Atkinson (1996). *Making Sense of Qualitative Data: Complementary Research Strategies*. Thousand Oaks, CA, Sage.

Estelles, E., & Gonzalez, F. (2012). Towards an Integrated Crowdsourcing Definition, *Journal of Information Science*, April 2012; vol. 38, 2: pp. 189-200.

Gano, S. and R. Kinzler (2011). Bringing the Museum into the Classroom. *Science*, AMNH **331**(6020): 1028-1029.

Horwitz, R., & Intemann, C. (2007). We Are Your Audience in D. Bearman & J. Trant (eds) *Museums and the Web 2007 Proceedings* [CD ROM]. Available: Archives & Museum Informatics, 2007. [November 12, 2008]. http://www.archimuse.com/mw2007/papers/horwitz/horwitz.html

Ito, J., L. Langa, et al. (2010). Remedial Evaluation of the Materials Distributed at the Smithsonian Institution's Annual Teachers' Night, Smithsonian Center for Education Museum Studies.

Kelly, L., & Breault, K. (2007). 'Developing Educational Websites: Investigating Internet Use by Students and Teachers' in E. Nardi (ed.) *Thinking, evaluating, rethinking: Proceedings from ICOM-CECA 2006 Conference,* Universita' Tre, Rome.

Kennedy, L. (2012) Museums Exploring New Territories: APP Building. *MUSE*. Canadian Museums Association. July/August 2012.

Kratz, S. & Merritt, E. (2011). Museums and the Future of Education, *On the Horizon*, Vol. 19 Issue: 3, pp.188 – 195.

Kolb, D.A. (1984). Experiential Learning: Experience as the Source of Learning and Development. Prentice Hall. Englewood Cliffs, NJ.

Laurillard, D. (2002). Rethinking University Teaching: A Conversational Framework FO the Effective Use of Learning Technologies. New York: Routledge Falmer.

LaBar, W. (2010). Can Social Media Transform the Exhibition Development Process? Cooking: The Exhibition- An On-Going Case Study. Liberty Science Center. *Museums and the Web Conference 2010.*

Lagoudi, E., Sexton, C. (2010). Old Masters at Your Fingertips: The Journey of Creating a Museum App for the iPhone and iTouch. The National Gallery, UK. *Museums and the Web 2010 Conference.*

Leftwich, M. and M. Bazley (2009). Pedagogy and Design: Understanding Teacher Use of Online Museum Resources. *Museums and the Web Conference, 2009.*

Marty, P. and M. Twidale (2004). Lost in Gallery Space: A Conceptual Framework for Analyzing the Usability Flaws of Museum Websites. *First Monday* 9(9).

Masri, L. and E. Grossman (2010 Pimp My Site Architecture: Reorganization and Usability Tools and Tactics to Reinvigorate Museum Web Sites on a Budget. In J. Trant and D. Bearman (eds). *Museums and the Web 2010: Proceedings*. Toronto: Archives & Museum http://www.archimuse.com/mw2010/papers/masri/masri.html

Mayer, R. E. (2001). *Multimedia Learning*. New York: Cambridge University Press.

Mayer, R. E. (Ed.). (2005). *The Cambridge Handbook of Multimedia Learning*. New York: Cambridge University Press.

Means, B., Toyama, Y., R. Murphy, M. Bakia & K. Jones. (2010). Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies. U.S Department of Education, Office of Planning, Evaluation and Policy Development Policy and Program Studies Service.

Meeker, M., Devitt, S. & L. Wu. (2010). *Internet Trends*. Morgan Stanley, NY.

Miller, E. & Wood, D. (2010). Recollection: Building Communities for Distributed Curation and Data Sharing . In J. Trant and D. Bearman (eds). *Museums and the Web 2010: Proceedings*. Toronto: Archives & Museum Informatics.

New Media Consortium (2010). *The Horizon Report 2010: Museum Edition* http://media.nmc.org/itunesU/HR-Museum/2010/2010-Horizon-Museum.pdf

New Media Consortium (2011). *Horizon Report 2011*: http://wp.nmc.org/horizon2011/

Pashler, H, McDaniel M. et al. (2008). Learning Styles: Concepts and Evidence. *Psychological Science in the Public Interest.* Vol. 9 No. 3. December, 2008.

Peacock, D. & Brownbill, J. (2007). Audiences, Visitors, Users: Reconceptualising Users Of Museum On-line Content and Services in J. Trant and D. Bearman (eds) *Museums and the Web 2007: Proceedings.* Toronto: Archives & Museum Informatics, published March 31, 2007 at http://www.archimuse.com/mw2007/papers/peacock/peacock.html

Project Tomorrow (2010) The New 3 E's of Education: Enabled, Empowered, Engaged How Today's Students are Leveraging Emerging Technologies for Learning. *SpeakUp 2010 Conference National Findings*. Retrieved from: http://www.tomorrow.org/speakup/pdfs/SU10_3EofEducation(Students).pdf

Russo, A. (2011) Transformations in Cultural Communication: Social Media, Cultural Exchange, and Creative Connections. *Curator: The Museum Journal*, 54: 327–346. doi: 10.1111/j.2151- 6952.2011.00095.x

Russo, A., Watkins, J. L. Kelly & S. Chan (2008) Participatory Communication with Social Media. *Curator: The Museum Journal,* 51/1: 21-31.

Saiki, D. (2010). "Interacting Online: A Content Analysis of Museum Education Websites." *Journal of Learning Design* **4**(1): 52-62.

Solas, N., (2010). Hiding Our Collections in Plain Site: Interface Strategies for "Findability". In J. Trant and D. Bearman (eds). *Museums and the Web 2010: Proceedings*. Toronto: Archives & Museum.

Stylianou-Lambert, Theopisti (2010). Reconceptualizing Museum Audiences: Power, Activity, Responsibility. Cyprus University of Technology. *Visitor Studies Association*, 2010, *13(2),* 130–144. DOI: 10.1080/10645578.2010.509693

Trant, J. and Wyman, B. (2006). Investigating social tagging and folksonomy in art museums with steve.museum. Taylor & Francis, Vol. 12, Issue 1. http://www.ra.ethz.ch/CDstore/www2006/www.rawsugar.com/www2006/4.pdf

Urban, R., Twidale, M. & P. Adamczyk (2010). Designing and Developing a Collections Dashboard**.** University of Illinois, The Metropolitan Museum of Art, *Museums and the Web 2010 Conference.*