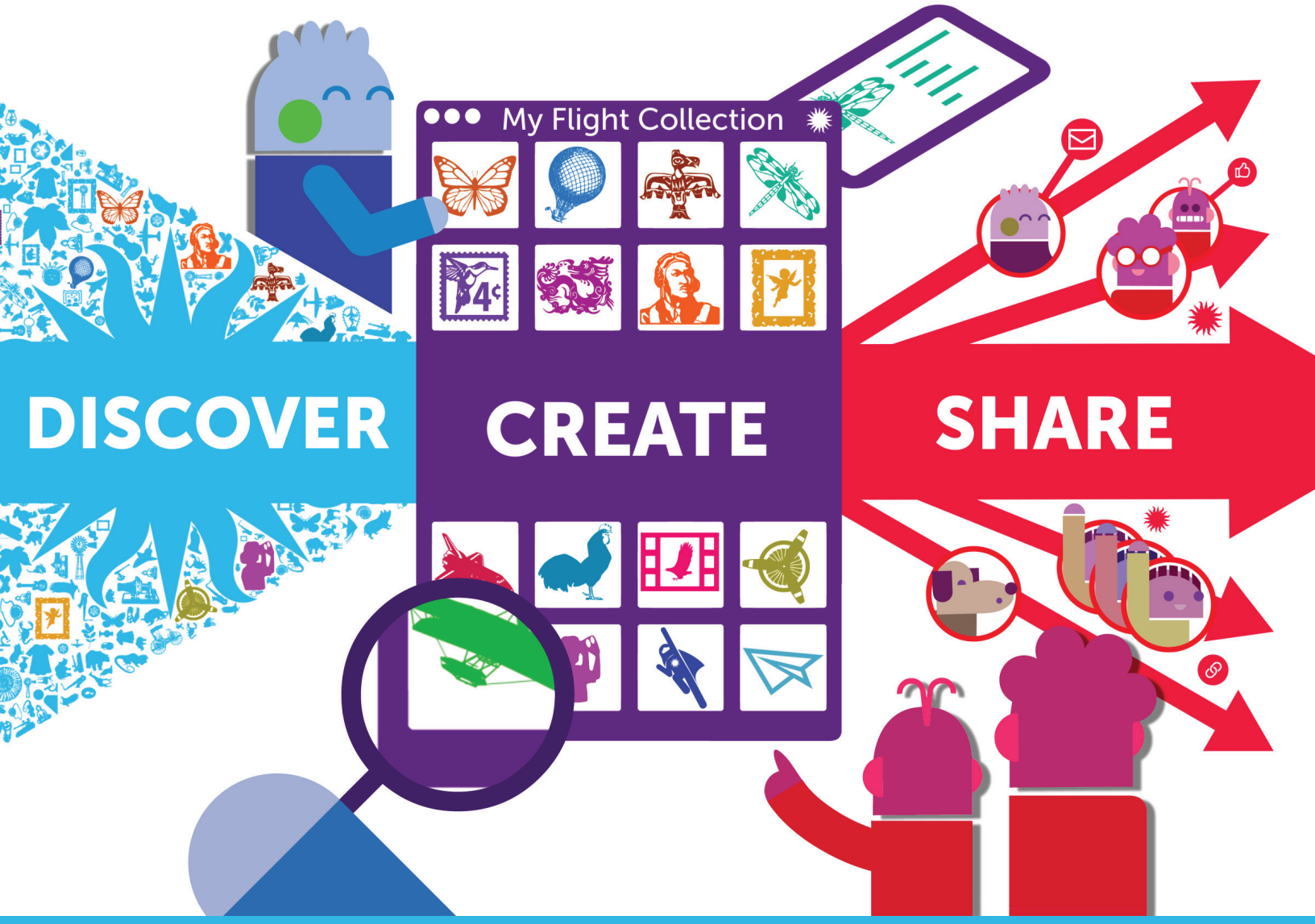

Smithsonian
Learning Lab

Curation of Digital Museum Content:
Teachers Discover, Create, and Share in the Smithsonian Learning Lab

Smithsonian Center for Learning and Digital Access,
with the School of Education at the University of California, Irvine

learninglab.si.edu

Curation of Digital Museum Content:
Teachers Discover, Create, and Share in the Smithsonian Learning Lab

Washington, DC
2018

This publication was made possible in part by a grant from Carnegie Corporation of New York.
The statements made and views expressed are solely the responsibility of the authors.

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Cite as:
Smithsonian Center for Learning and Digital Access with the School of Education at the University of California, Irvine (2018). Curation of Digital Museum Content: Teachers Discover, Create, and Share in the Smithsonian Learning Lab. Retrieved from http://s.si.edu/CurationofDigitalMuseumContent

Interior design: Mimi Heft

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Acknowledgements

This project would not have been possible without the expertise and support of many people at the Smithsonian Institution, the University of California, Irvine, and several external partners.

Many administrative staff members played essential roles throughout the project's two years. Alejandro Gutierrez, Jr., at the Smithsonian, and Johnny Ochoa at the university negotiated all of the contractual details two large organizations require. Eskender Kejela, Joan Oyedokun, and Halina Izdebska in the Smithsonian's Office of Sponsored Projects assisted in processing the grant and providing financial reports. Deron Burba and Matthew Jenkins in the Smithsonian Office of the Chief Information Officer offered valuable advice during the building of the Learning Lab and guidance as problems arose. Flint Hamilton, Helen Dockery, and Tina Hester supported procurement and travel arrangements, and Rhett Ransom ensured that teachers had working computers in each of the workshop sessions—all staff members in the Smithsonian Center for Learning and Digital Access (the Center).

This project included collecting data using different methodologies and from different sources. Doron Zinger (UCI School of Education) and Nicole Gilbertson (UCI History Project) led this effort with support from Isabel Amador, Risa Hatanaka, Sara Quach, Mathias Gomez, and David Liu in the School of Education at the University of California, Irvine. The evaluation, grants, and data office of the Allegheny (Pennsylvania) Intermediate Unit conducted classroom observations and summarized their findings in a final report. This work was complemented by interviews coordinated by Melissa Wadman, an evaluator in the Center. Linda Muller and Kate Harris, teaching coaches funded by the grant, kept logs of meetings with teachers and classroom observations that provided insights into how the Lab was used in daily practice. Danee Gaines Adams, Eva Goodyear, and Aaron Goldstein in the Smithsonian's privacy office and Susan Askren of the Smithsonian's institutional review board reviewed evaluation methods and plans. Two independent research projects also informed our work. Elizabeth Cohen, an independent scholar and a Smithsonian fellow in museum studies, interviewed Smithsonian staff about how they thought about building collections. Emily Esten, a graduate student in public humanities at Brown University and an intern at the Smithsonian, studied how 25 Smithsonian units used the Lab and interviewed staff in eight units for case studies documenting how it was adapted to serve different museum functions. Melanie Blanchard, a registrar at the Smithsonian National Museum of American History, advised us on resource metadata and how to resolve problems on access as part of her Emerging Leaders Development Program.

Two cohorts of Allegheny County teachers participated in yearlong training, built collections in the Lab, and provided invaluable feedback. Due to the restrictions

inherent in research and to protect their privacy, we are unable to acknowledge them by name. Given how busy teachers are, we greatly appreciate their commitment to this project and their dedication to quality instruction for their students.

Professional development workshops for the two cohorts were planned by a team that included Mariruth Leftwich of the Senator John Heinz History Center (a Smithsonian Affiliate museum), Paul Cindric of the Allegheny Intermediate Unit, Tracey Armant of the Grable Foundation, Kate Harris and Linda Muller (teaching coaches), as well as the university's evaluators and the Center's educators. Together they reviewed feedback from workshop evaluations and teacher interviews to improve the training over the two years, as reflected in the workshop evaluations and published research. Museum curators and educators led some of the sessions, in galleries or during online interactive conferences. Presenters included Mariruth Leftwich, Sierra Green, Leslie Przybylek, Amanda McAllen, and Nate Rodda from the Heinz History Center; Erin Peters from the Carnegie Museum of Natural History; Elizabeth Dale-Deines and Peg Koetsch from the Smithsonian American Art Museum; Elizabeth Eder and Keith Wilson from the Freer Sackler Galleries; Steve Williams from the National Air and Space Museum; Matthew Hoffman and Shannon Perich from the National Museum of American History; Kathy Swan from the University of Kentucky College of Education; Jourdan Englert from Elizabeth Forward Middle School; and Briana Zavadil White from the National Portrait Gallery. This collaboration with the Heinz History Center was facilitated by Jennifer Brundage from the Smithsonian Affiliations.

Andy Goodman led a storytelling workshop to capture users' stories about the Lab, each representing a different educator experience and role. We are particularly grateful to the four educators whose stories are included in this report—Patty King (West Mifflin Area High School), Tom Gray (Shaler Area Middle School), Jean-Marie Galing (Fine Arts Department, Fairfax County Public Schools), and Carole Geneix (Washington International School).

All of the staff of the Smithsonian Center for Learning and Digital Access contributed to this project and all of them supported it in many ways. Ashley Naranjo and Tess Porter led the teacher workshops, convening team planning meetings and making arrangements, and each created more than 100 topical or model teaching collections for use by cohort teachers. Tracie Spinale led the effort to ensure that the Lab met all privacy and security requirements for children and coordinated review of all published collections for appropriate content. Pino Monaco and Darren Milligan worked together on building the Lab dashboard to present data on user collections. Pino worked closely with Doron and Nicole on analyzing the data and responding to questions, in particular about resource metadata. Melissa Wadman worked with Pino on securing the approval from the Smithsonian's institutional review board. Cody Coltharp advised the team

on ways to integrate state-of-the-art technology into collections and provided models to show us how to do it. Michelle Smith, Pino Monaco, and Hannah Onstad edited drafts and worked on the overall design of the final report. The Center's staff actively participated in biweekly conference calls with the university team to analyze data and discuss findings. The discussions were lively and challenging and led to a deeper understanding of the possibilities.

The Carnegie Foundation of New York provided guidance throughout the two years, with Saskia Thompson and Marisa Lupo advising on the programming and reporting and Mary Gentile on the fiscal requirements. Gregg Behr at the Grable Foundation helped us to see how the two grants could complement each other.

Finally, we are grateful to the ongoing support from senior leadership in each of our Institutions: Howard Gillman, Chancellor of the University of California, Irvine, and Richard Arum, Dean of its School of Education; David Skorton, Secretary of the Smithsonian; and Patty Bartlett, Assistant Secretary for Education and Access.

And this project is dedicated to Claudine Brown, an educator who led the education effort at the Smithsonian and inspired all of us to believe that museums can make a difference.

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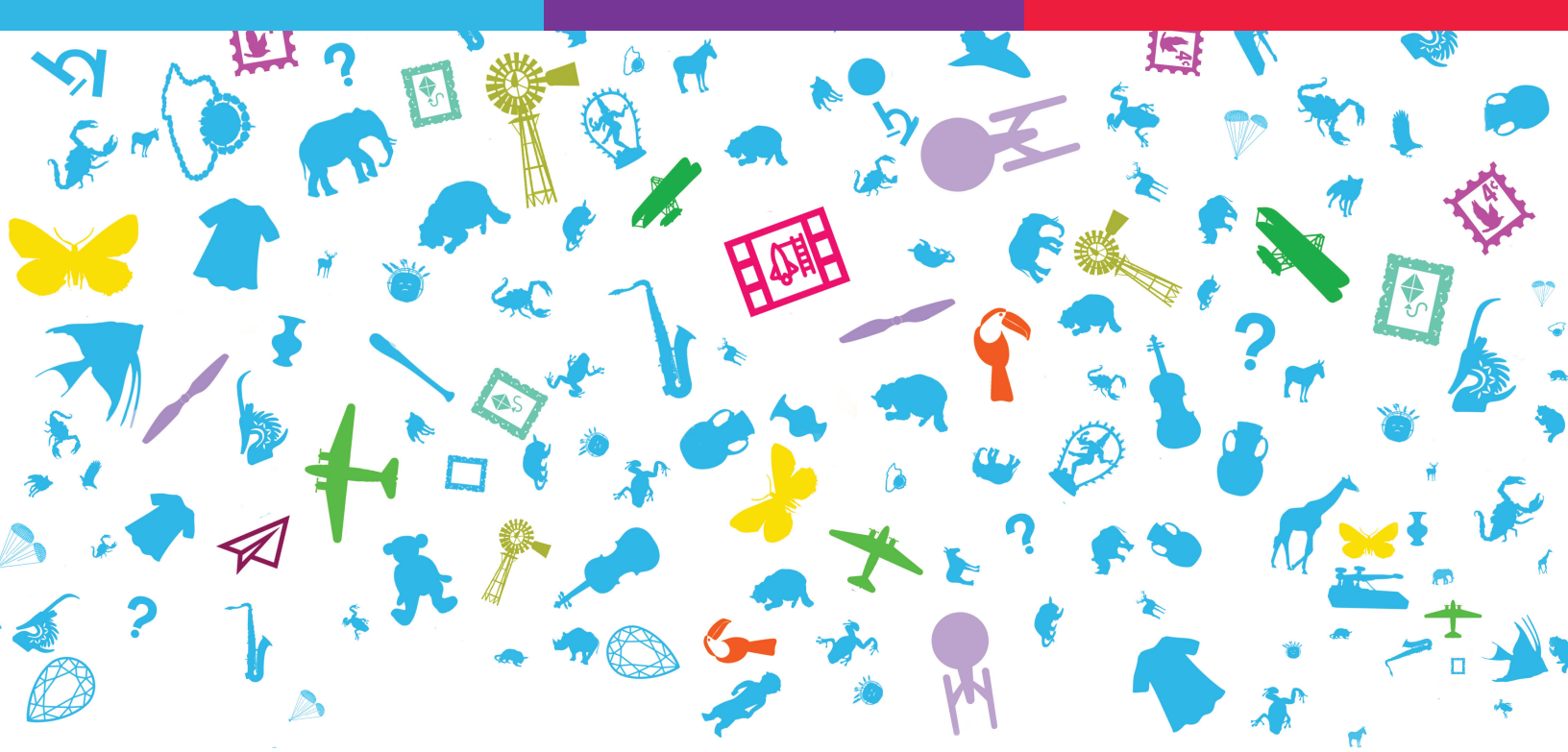
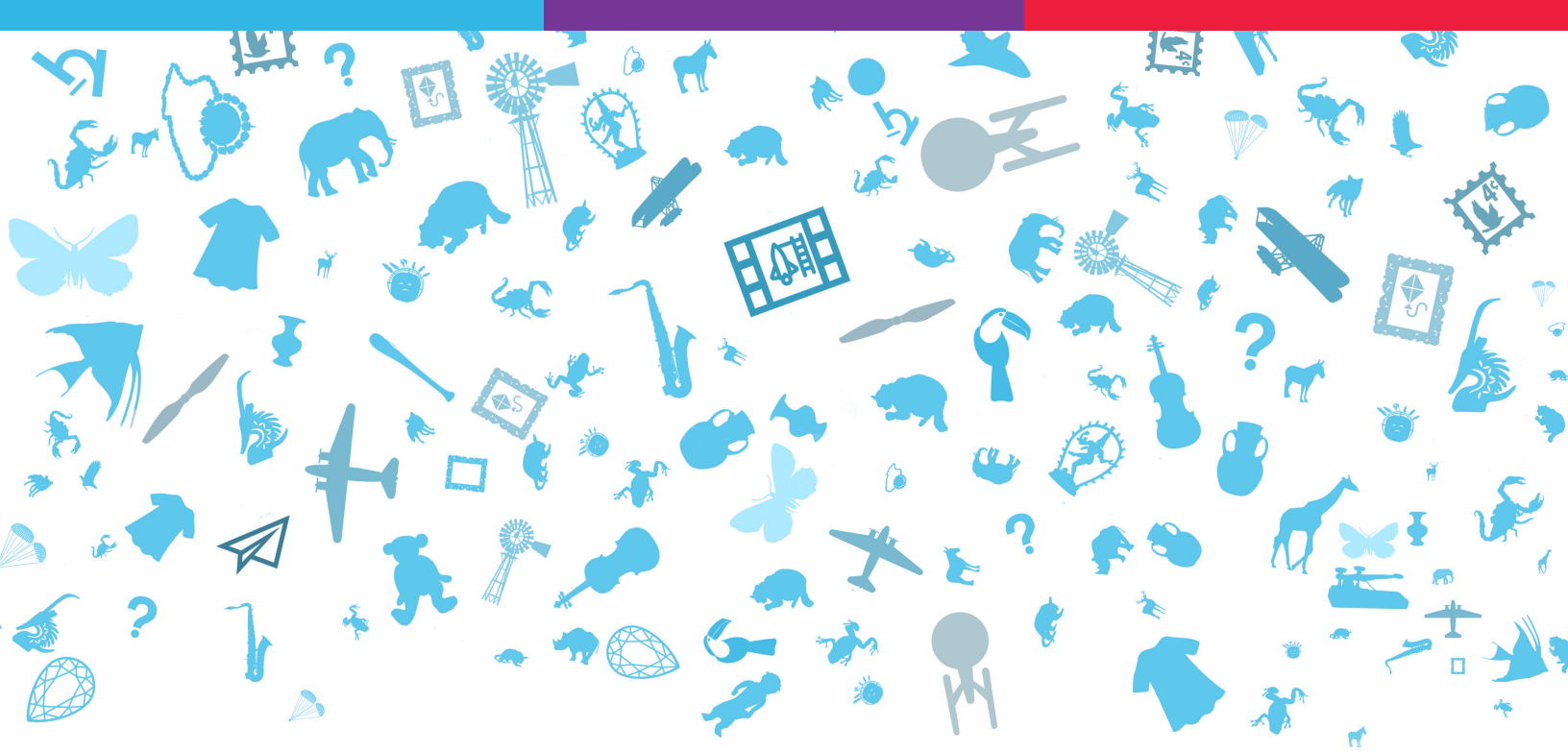


PART I
The Research



Introduction

In the last 20 years, the digitizing of information has transformed education. In 2002, the worldwide digital storage capacity overtook total analog capacity, and as of 2007 almost 94% of our memory is in digital form. Much of this information is available to everyone (Hilbert, 2011).

Schools are making substantial infrastructure investments to improve access by purchasing devices for students and adding broadband capacity. In 2014, Baltimore County Public Schools, as an example, committed more than $200 million for laptops. Projections for sales of computer and software in education are $21 billion by 2020 (Singer & Ivory, 2017). Online education is also growing, some estimating 20% a year (Allen & Seaman, 2005).

Cultural institutions are entering this new digital world by making their resources available. Open educational resources (OER) are digitized materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research (Baker, 2008). The use of OER in education has been growing for some time but mostly outside classroom settings, yet the benefits of OER to education are clear (Baker, 2008).[1] Teachers gain access to the best variety of resources for instruction. At the same time there are barriers to greater use of OER. Teachers lack skills and time for creating materials and there is no reward system for them to produce open content (Hylen, 2007).

Like other museums, libraries, and archives, the Smithsonian Institution is now making its holdings available to the public through digital technology. These holdings include 154.8 million objects and specimens, 157.3 thousand cubic feet of archival materials, and 2.1 million library volumes (November 2017), with less than 1% on display at any given time. Digitization provides an opportunity to reach new audiences across the nation and throughout the world.

Research relevant to digitization has mostly focused on access—how users find resources. There is less research on how people use digital museum resources and very little that focuses on specific audiences such as educators. The potential of educational technology to connect students with materials (e.g., data and primary sources) that engage them in authentic educational experiences remains unrealized (Lindquist & Long, 2011). Addressing the needs of teachers and students is the mission of the Smithsonian Center for Learning and Digital Access (the Center), which works with all the Smithsonian's museums and research departments to make their content more widely available and used.

Recognizing the potential of digital technology for learning, the Center has focused on educators and conducted research on how they use print and online educational materials. One of its primary findings is that teachers must be able to

1. For a summary of proceedings of a meeting held by the National Science Foundation to discuss opportunities and challenges in the development and use of open educational resources (OER), see "Understanding Open Educational Resources: Next Step for Research." June 16–17, 2016. Arlington, VA https://www.nsf.gov/pubs/2018/nsf18200/nsf18200.pdf

easily locate and adapt resources to meet the needs of their students.[2] Teachers modify materials produced by the Smithsonian by changing images to better represent their students, adjusting reading levels of texts, and adding local examples, among other things.

As a result of this research, the Center created the Smithsonian Learning Lab (the Lab), a platform for discovering resources and creating with them. Teachers can discover millions of images (i.e., specimens, artworks, and artifacts), recordings, and texts, each with descriptive information (metadata). They can create their own collections by choosing and organizing resources, even uploading their own content or that of other providers. To customize their collections based on their students' needs, teachers can use tools to add text, tags, annotations, discussion questions, and quizzes. In addition, they may choose to share what they create through social media, by embedding collections on other websites, or by publishing publicly on the Lab.

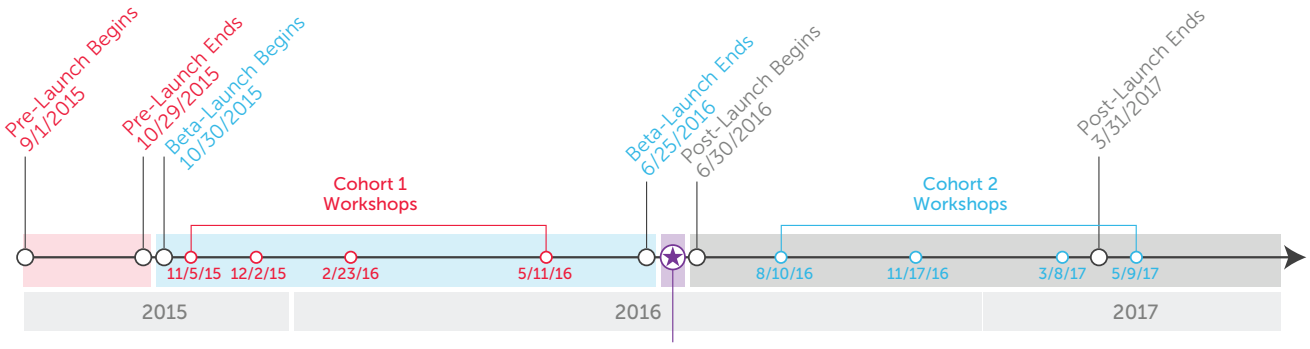
Teachers must be able to easily locate and adapt resources to meet the needs of their students.

With support from the Carnegie Corporation of New York and the Grable Foundation, the Center is continuing its work to better understand how teachers and their students use digital content in the Lab (see Figure 1 for project timeline). The Carnegie Corporation provided funding to answer four fundamental questions (project objectives): how teachers find digital resources in the Lab, what they do with them, what supports they need, and how the use of digital content impacts their students. The Grable Foundation funded work with two cohorts of teachers in Allegheny County, Pennsylvania. Each cohort of teachers attended 4 full days of professional development on using the Lab and worked with a coach in their classroom at least four times. Cohort 1 used the beta version of the Lab and cohort 2 used the final version that was refined based on feedback from the beta period.

The cohort teachers' insights and experiences were invaluable in advancing our understanding, improving the user experience for other teachers, and revealing new questions for further study.

2. To see a summary of this research and links to related articles and reports: https://learninglab.si.edu/about/research

PROJECT TIMELINE



PRE-LAUNCH:
Sep 1–Oct 29, 2015

- Smithsonian Learning Lab (the Lab) debuts in beta form, October 2015

BETA-LAUNCH:
Oct 30, 2015–June 25, 2016

- Cohort 1 – 33 middle school teachers begin professional development*
- Cohort 1 Workshops
  November 5, 2015
  December 2, 2015
  February 23, 2016
  May 11, 2016
- Observations, survey responses, and Google Analytics data is collected
- Changes to the Lab were made and new features released based on the findings during Beta Launch period

LAUNCH:
June 26–29, 2016

- Lab officially launches at the **ISTE (International Society for Technology in Education) conference,** June 26-29

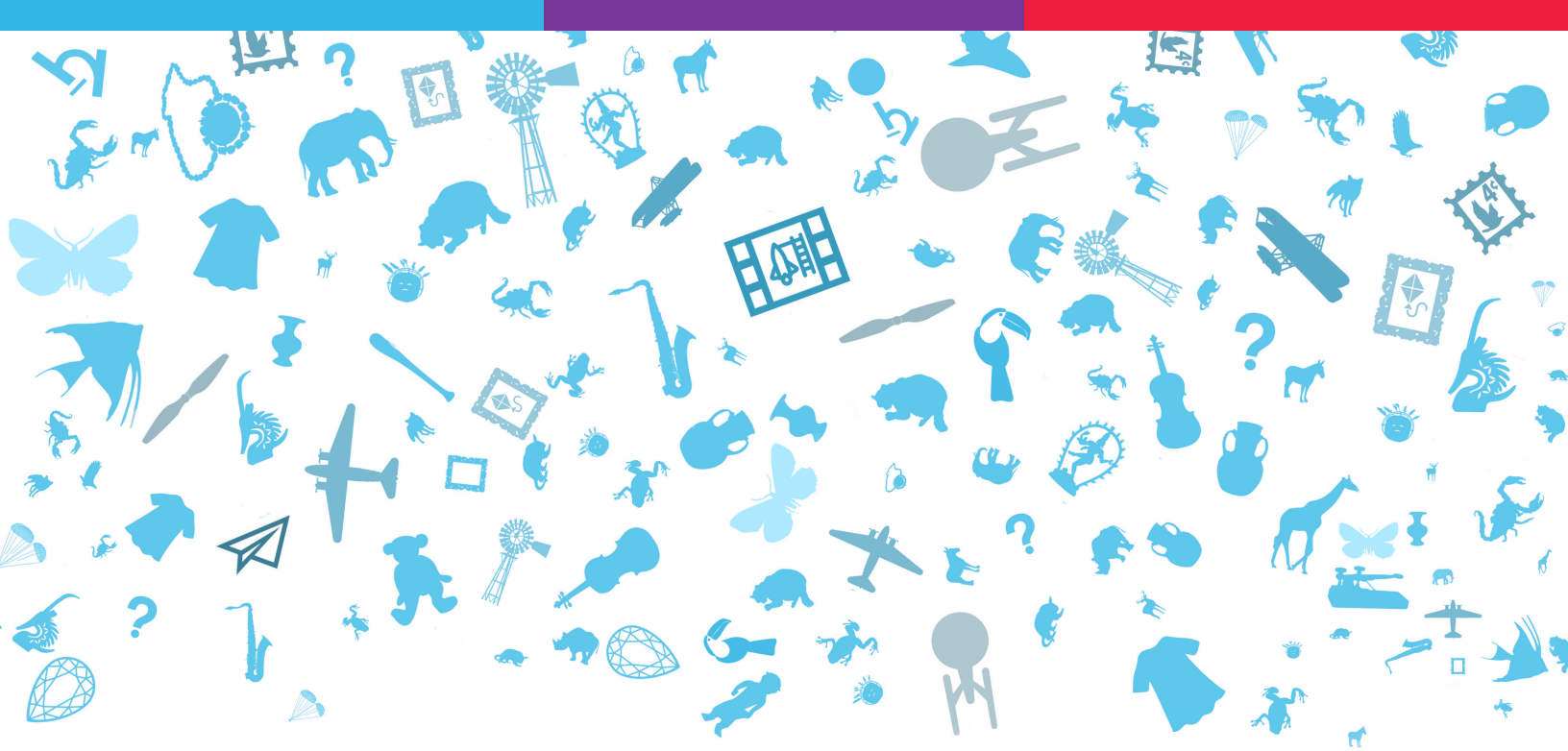
POST-LAUNCH:
June 30, 2016–March 31, 2017

- Summer Teacher Institute professional development sessions with the Smithsonian American Art Museum and the National Portrait Gallery, June/July 2016
- Cohort 2 – 34 high school teachers begin professional development**
- Cohort 2 Workshops
  August 10, 2016
  November 17, 2016
  March 8, 2017
  May 9, 2017
- Completion of analysis of 1,000 teachers' pathways and experiences in discovering resources and creating collections in the Lab
- Completion of analysis of observations and interviews of cohorts 1 and 2

* Cohort 1 comprises **33 middle school social studies** teachers and media resource specialists from the Pittsburgh area who received 4 days of professional development that focused on working with the Lab; cohort 1 participated in three monthly online workshops to develop a community of practice, beginning in November 2015 and continuing through May 2016.

** Cohort 2 comprises **34 high school U.S. History and English/Language Arts** teachers and media resource specialists from the Pittsburgh area who received 4 days of professional development that focused on working with the Lab; cohort 2 participated in four monthly online workshops to develop a community of practice, beginning in August 2016 and continuing through May 2017.

Figure 1. An overview of the project milestones.



Project Objectives

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Project Objective 1

Identify strategies for making it easier to find teacher-created digital collections

As schools move away from textbooks toward more frequent use of digital resources, teachers and students experience challenges in finding, assessing, and using these resources. The American Association of School Librarians and scholars consider search to be a key element of digital literacy, like learning a language or subject. Like any literacy, it requires having discrete skills as well as accumulating experience in how and when to use them (American Association of School Librarians, 2007; Notess, 2007; Granata, 2017). The Digital Public Library of America published a study on how teachers and students discover, navigate, and use digital resources that revealed the most common teacher complaint was how difficult it was to find what they wanted quickly and efficiently (Abbott & Cohen, 2015). Clearly, teachers and students are experiencing challenges in searching, and the question remains whether this is an issue with skills or technology or both (Bergson-Michelson, 2012).

In order to identify ways for making it easier to find both Smithsonian resources and teacher-created collections,[3] this study addressed the following questions:

- What is the typical search experience like?
- What search techniques work or do not work for educators?
- How do different characteristics of "resources" and "user-created collections" help or hinder teacher searches?

Basis of Findings

The research team employed a variety of methods to gather both quantitative and qualitative information on users' search experiences using the Lab, including Google Analytics and the Lab dashboard reports (all Lab users, registered and non-registered), an online user survey (for Lab registered users), cohort teacher and coach logs, focus group transcripts, professional development workshop evaluations, evaluator and coach observations, and Lab site change documentation (Appendices A and B). Most of the survey responders (87%) identified themselves as educators.

3. In the original grant submission, "collections" were called "sets."

Key Findings

Teachers need search skills to achieve successful results.

Searches account for 21% of all site visits to the Lab (All Lab users; Google Analytics, November 1, 2015–October 19, 2017). Of user survey respondents (Lab registered users), 85% reported searching for resources and 51% for collections (Appendix B, Q7 and Q11).

The majority of Lab registered users searched using a keyword (World War II posters) or a topic (ecology or Civil War) (Appendix B, Q8).[4] The search yielded results organized as "resources" and "collections." The resources are represented visually as thumbnail images; the collections are represented as a thumbnail of the first item in the collection (Figure 2). Using a cursor, a user can roll over the thumbnail to see the title and source or click on the thumbnail to view a larger image and read more information.

The majority of Lab registered users found what they were looking for in resources (76%) and collections (82.9%; Appendix B; Q9 and Q13), but often only after repeated trials. While most teachers were successful in searching, they encountered both

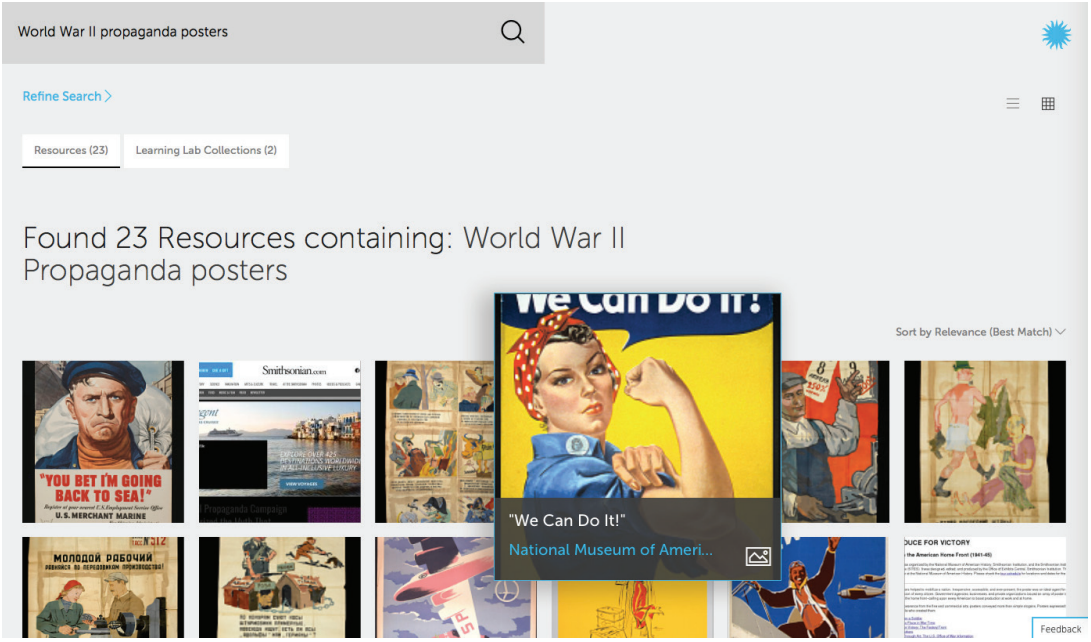


Figure 2. Search results appear as the number of "resources" found and the number of "collections" found. The user has chosen to display resources.

4. A keyword search looks for words anywhere in the record. Subject-based searching allows searching for resources based on the subject of the item, not on keywords appearing within a document. Effective subject-based searches usually work within controlled vocabularies, meaning that the database uses selected terminology to represent specific topics. (http://www.columbia.edu/cu/lweb/help/clio/keyword.html).

intrinsic and extrinsic challenges. Intrinsic challenges included a lack of familiarity with visual literacy skills, museum resources, and research strategies using academic databases. Extrinsic challenges included inadequate metadata[5] for their purposes, teachers' limited time, and the need for additional tools and training (Figure 3).

Teachers found too many, too few, or irrelevant resources.

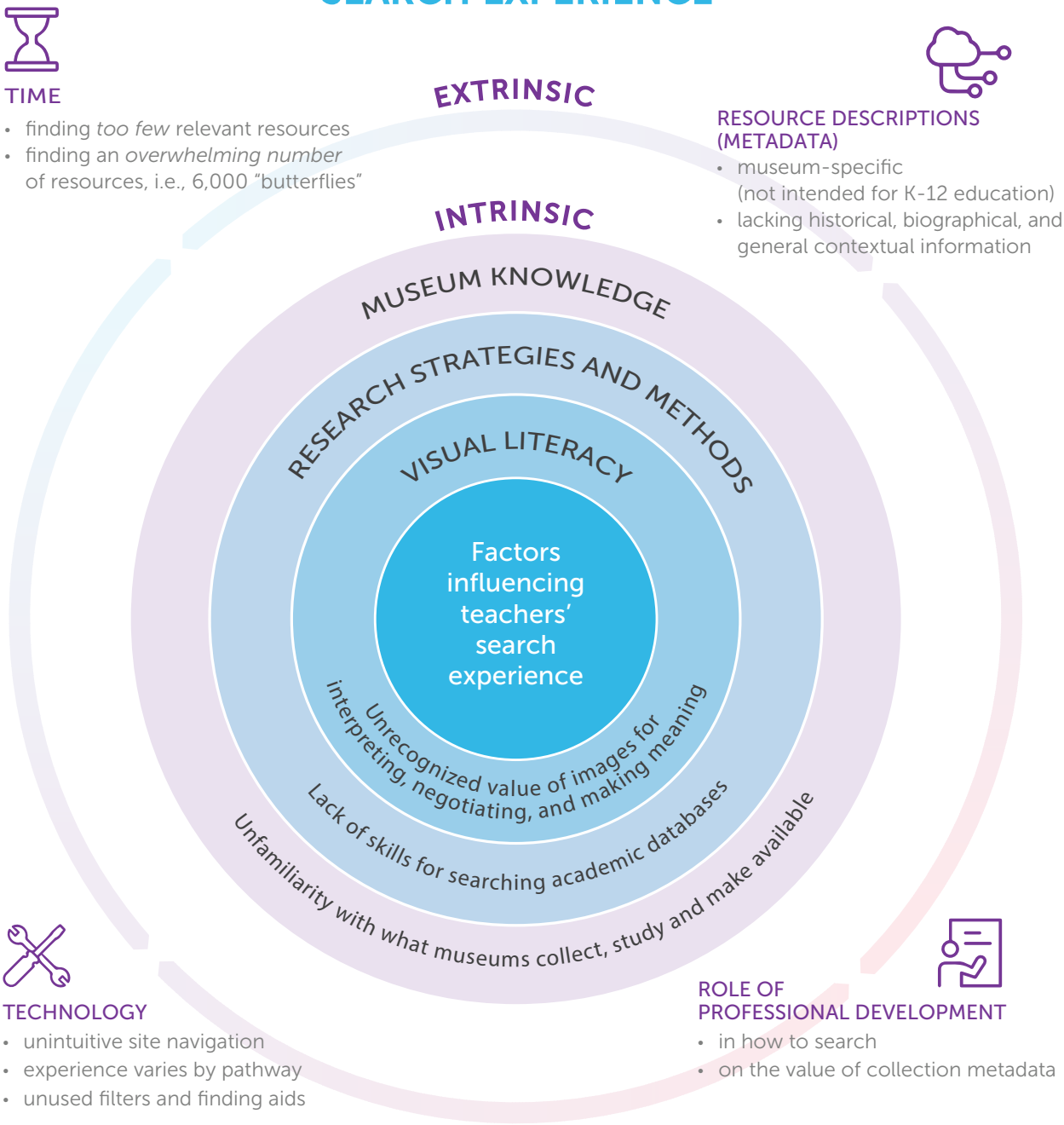
Comments in cohort teachers' implementation logs and classroom observations provided a closer look at the user experience. Searches using a keyword or topic often resulted in too many or too few results or ones that were not relevant. For too many, a teacher who searched for "butterflies" found almost 6,000 resources; for too few, a teacher who searched for "Native American folktales" found only 5. For irrelevant, one teacher noted, "In the search you put in words and things come up that have nothing to do with what you searched for and it made it very difficult." A teacher might enter "columns" intending to find architectural columns and discover 7,000 resources that include a car steering column, columns in a ledger, or newspaper columns. Given teachers' time constraints, this was a barrier to deeper use (see also page 13, Museum resources often lack information that teachers expect and need.).

Teachers often did not refine their searches by using different search terms or filters.

In some cases, users found limited results because they tried only one keyword. For example, a search for "Vietnam activist" found 38 resources, while a search for "Vietnam protester" resulted in nearly twice as many, 71. Few teachers refined searches to improve their results. Only 22% of the survey respondents reported conducting refined searches (Appendix B, Q8) and only 14% of the sessions documented by Google Analytics included refined searches (registered and non-registered users). Another way users could refine searches was by using filters. The Lab included some filters at launch; for example, you could filter by a specific Smithsonian museum. Teachers requested additional, more relevant filters. These were added in the second year, for example, the ability to search collections by subjects taught in school. For more information on the filters, see Appendix C.

5. Note: See glossary for definition.

UNDERSTANDING TEACHERS' SEARCH EXPERIENCE



Improvement Strategies:

- building more topical and teaching collections
- professional development that focuses on digital research strategies
- new guidelines for creating metadata that foster a K-12 relevant approach
- enhanced navigational supports and filters within the Lab

Figure 3. Teachers experience both intrinsic and extrinsic challenges when searching.

Educator Spotlight: Successful Searches Lead to Rewarding Experiences

Patty King is a librarian at West Mifflin Area High School (PA) with a passion for connecting people with books and information. She enrolled in Smithsonian professional development because she was curious about how the Lab would make museum resources accessible.

As the workshops got underway, Patty saw that she was the only librarian in the group. She observed the frustration that teachers experienced when searching the Lab and not finding what they wanted. Patty immediately realized that she could help teachers and students learn to do better searches.

As a librarian, she understood that they are used to subject-based searches, while the way to effectively search the Lab is by keywords. She put together a brief training to introduce her colleagues to keyword searching.

Patty immediately realized that she could help teachers and students learn to do better searches.

Back at school, Patty saw students try a search term such as "racism during the Civil War" and not find results. Using Patty's suggestions, one student started with an image of a uniform belonging to an African American soldier, then read its metadata to see how scholars had described that resource. After identifying keywords in the metadata, he used the very same words as the experts to locate more resources.

Searching for digital resources in an academic database requires skills. Patty notes that librarians can be active partners with teachers in guiding students in learning and refining these important skills.

Searching academic databases is different from other types of searches.

Internet users have become accustomed to advanced search technology (such as that provided by Google). In contrast to commercial search engines, the Lab search functionality is basic: it searches through resource descriptive metadata and returns results based on a simple measure of relevance. This is different from search engines that use complex algorithms to analyze search terms and possible solutions, including quality of the source and information known about the searcher (such as geographic location and previous search history).

Another problem observed during workshops and classroom observations is that some teachers were looking for more general information that would be better sought in an encyclopedia or reference book (e.g., definitions, background history). As teachers become more accustomed to what museums make available, they will become more proficient in finding what they need.

Museum resources often lack information that teachers expect and need.

Metadata is the information associated with a digital resource. Each digital resource in the Lab has associated metadata based on museum standards, created for the purposes of cataloging and describing the item, which typically includes the name of the donor, date it was acquired, an identifier number, name of the maker or artist, measurements, and a brief physical description. The description rarely provides enough information for the general public to understand its educational value or potential. The metadata standards for educational digital resources proposed by the Learning Resource Metadata Initiative (LRMI)[6] prescribe very different information, including educational standards addressed, appropriate grade level, and how to use them. This disconnect between metadata standards means resources will not be retrieved or not fully realized as educational resources (Egger, Hossfeld, Schatz, & Fiedler, 2012; Drucker, 2013; Chen, Dörk, & Dade-Robertson, 2014).

Another problem is the specialized language unique to each discipline. For example, a cohort middle school teacher was searching for content for a world history course. When she searched using the topics "ancient Greece" or "Bronze Age," she found no relevant resources. If this teacher had searched "Greek archaeology," she would have found 539 resources. Teachers encounter the same problem in other disciplines. An art teacher looking for a photograph may need to specify "daguerreotype" or a science teacher who searches by the common name "butterfly" will not find specimens unless she enters the Latin name "Lepidoptera" (Figure 4).

Teachers searching for published collections may also encounter problems, but for different reasons. When a teacher publishes a collection, she can add information (metadata). Based on the information fields recommended by the LRMI, users are prompted when they publish to use drop-down menus to add the most important fields.[7] These fields include title, general description, content/subject area, grade level, alignment to specific national education standards, resource types, and intended users. For published collections, this metadata helps other users to find the collection through the Lab and Google searches, and guides other users in how to

6. Note: See glossary for definition.
7. For a full discussion of how the most important LRMI fields were determined: https://learninglab.si.edu/about/research

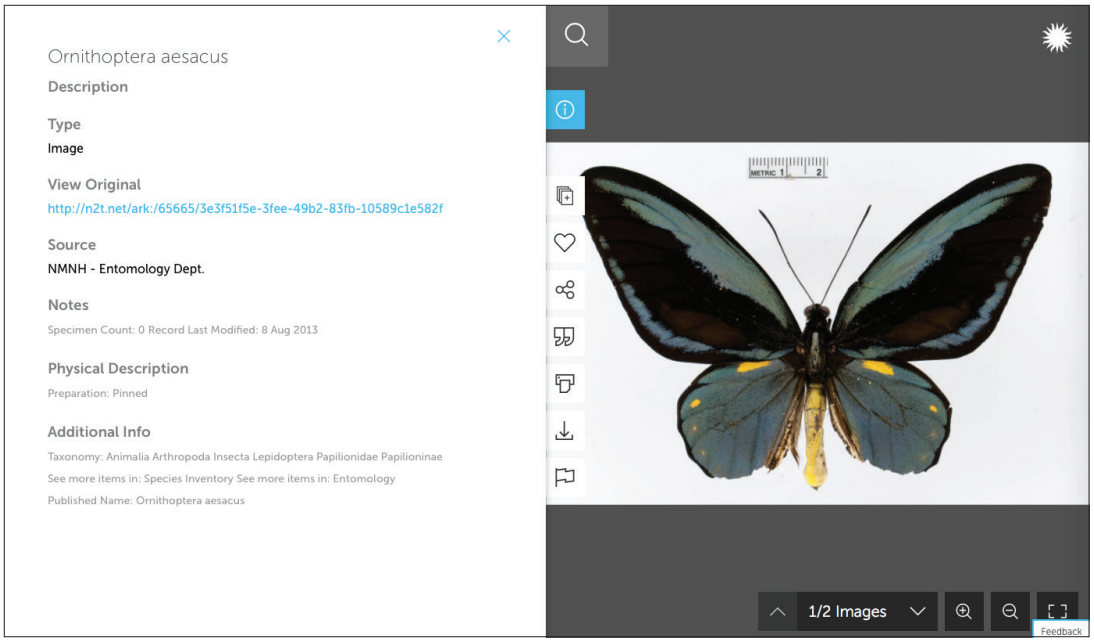


Figure 4. Specimen with scientific taxonomy in its metadata.

use it. However, users vary in whether or not they add information and which fields they use, which makes the discovery of their collections more difficult. In the future, as more collections are published, it will be important to have filters and strategies for refining these collection results. For example, a user may want to filter results to see only student collections, a capability that does not currently exist. (For a more detailed discussion of collection metadata, see Project Objective 2).

Users' pathways to the Lab affected their experience.

Not surprisingly, by considering the number of resources discoverable through the Lab, a high number of users accessed the site directly from Google or other search engines (organic search), landing directly on a page for a single resource. Throughout the Lab's beta period, this behavior accounted for 57% of the sessions and it was observed that many users were not proceeding to other areas of the site (single page session bounce rate 59%;[8] Table 1). During the post-launch period, when changes to the lab were implemented (e.g., online supports for first time users to the Lab; Appendix C), the bounce rate decreased and unique page views per day increased (Table 1).

Search is how teachers find what they need; the next section will be about what they create with the resources they find.

8. Note: See glossary for definition.

TABLE 1. LAB USERS' BEHAVIOR DURING THE BETA AND POST-LAUNCH PERIODS

Google Analytics - All Users	Beta	Post-Launch
Unique Page Views (N)	394,480	1,183,650
Unique Page Views/Day (N)	1,730	3,512
Sessions (N)	91,000	247,500
Sessions/Day (N)	399	734
Single Page Session Bounce Rate (%)	59	48
Accessed Site via Organic Search (%)	57	32
Total # of Collections Created (N)	3,169	8,321
Total # of Collections Published (N)	507	1,709

Data showed that a higher percentage of Lab users accessed the site via an organic search during the beta period than during the post-launch period. During the post-launch period, the unique page views per day increased and the bounce rate decreased.

Project Objective 2

Determine the characteristics of collections teachers made and the tools they used

What did users make in the Smithsonian Learning Lab and what kinds of digital resources had the most appeal or purpose for them, as evidenced by what they included in collections? The research reveals patterns and preferences, the impact of metadata on the use of resources and collections, and issues concerning the appropriateness of user uploads. For future directions, this analysis suggests the value of training, the cultivation of and support for "power users," and models to increase the use of tools and effective teaching strategies in collections.

Basis of Findings

This research question investigated the collections made by teachers in Allegheny County as well as those made by users who were untrained, users who may have attended brief online or in-person workshops, or Smithsonian staff members, from November 1, 2015, to March 31, 2017. The findings presented here are based on coach and classroom observations of the cohorts and on reviews of user-created collections (Appendix A). Cohorts 1 and 2 created 671 collections (431 original—meaning not copied and adapted collections—and 240 copied). Of these collections, 178 were published and therefore searchable by other users (72 were published by cohort 1 and 106 were published by cohort 2). Out of the 178 published collections, 125 are original. The 125 original collections (45 created by cohort 1 and 80 created by cohort 2) are analyzed and their characteristics compared with published collections by all users.[9] Registered Lab users created 15,000 collections and published 3,100 of them from November 1, 2016, to October 30, 2017.[10] Corroborating evidence from other studies has been included when relevant.

Key Findings

Teachers made three types of collections.

A collection is a group of resources that has been aggregated by a Lab user. The collection may include a variety of types of resources—videos, images of an object, texts—and may include the use of tools to add features—quizzes, user-created text, annotations. The creator may choose to publish the collection so that other people will be able to find, copy, and use it.

The ideal last step in publishing a collection is adding detailed metadata—to make it easier for others to find and use it. When collection metadata is insufficient, another

9. One of the reasons for making the comparison was to investigate the impact of professional development on the characteristics of collections.

10. For the time period designated, there were 17,882 registered Lab users.

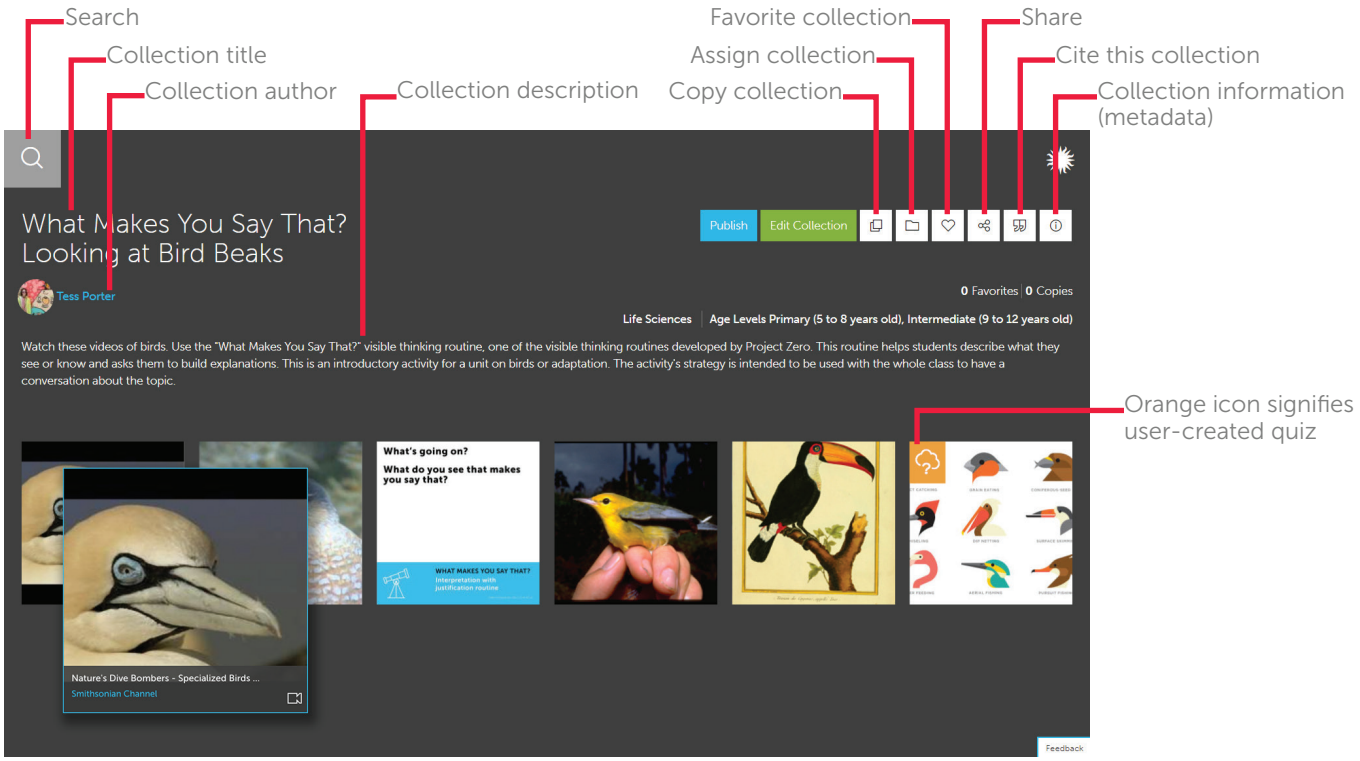


Figure 5. This user-created teaching collection includes videos, images, a thinking routine, and a quiz. When a user hovers over each resource, he sees its title, source, and media type. Clicking on a resource opens it to show additional information.

user is unable to determine the purpose and know how to use it. One of the goals of this project was to understand the types of collections and how they were used. When collection metadata was insufficient, researchers relied on classroom observations and interviews. This analysis indicates that with some overlap, published collections are of three types, depending on their purposes.[11] While all of them are aggregations of resources, each has a different purpose as follows:

1. to address a topic or theme (topical collections)
2. to function similarly to a lesson plan (teaching collections)
3. to provide students with independent work (student activities).

Topical Collections

- Aggregate resources on a topic or theme
- May include background or contextual information

For several reasons, the number of topical collections exceeds any other type of collection.

Making a topical collection can be a user's way of getting to know what the Lab's database contains and how to use basic functions such as naming and saving a

11. Fields were added to collection metadata so that creators can classify a collection as topical, teaching, or student activity.

collection. In fact, the first thing most users make in the Lab is a topical aggregation ranging from a few images or videos on a topic (e.g., "pandas") to others for which selection may require more knowledge or thought (e.g., "causes of the Civil War"). This type of aggregation may be particularly popular because of its versatility. The coaches observed the following uses of topical collections:

- For inspiration: resources (usually images) to stimulate creative writing or artwork. For example, an educator made a collection of origin stories from different cultures for this purpose.
- To provide context: resources that provide background and information on an issue. Examples include a collection with many items relating in some way to women's suffrage, and another illustrating the historical context of a novel.
- As the basis for projects or activities: resources selected by an educator for later use by students. As examples, a teacher preselects images of the U.S. presidents for students to use in media presentations or asks students to analyze how portraits reflect various presidential roles and duties. Other purposes include assembling resources for students to use in a project. By eliminating the need for student searches, this allowed more time for the activity.

Teaching Collections

- Aggregate resources on a topic or theme
- Include instructional strategy(ies) and/or features (i.e., uploaded worksheets or tools used to add features)

Designed for teachers to adapt and use in their own classroom and similar to a lesson plan, what differentiates these collections from the topical is that they include some form of instructional strategy. Sometimes the teacher includes this content in the "description" of the collection; in other cases, the teacher uploads it into the collection, as in the case of an "Ancient India" collection that includes eight Smithsonian and uploaded resources paired with a four-step process for analyzing them.[12]

These collections are intended for direct instruction, as in this example, which was one part of a larger classroom activity on ancient culture.

Student Activities

- Aggregate resources on a topic or theme
- Usually include interactivity

When the Smithsonian was conducting research for the development of the Lab, several teachers, particularly those at middle school and above, were interested in student rather than teacher use of such a platform. Teachers now have greater access to devices for their students, and their schools are continuing to make significant investments in technology and seek a wider variety of instructional materials via OER.

12. See https://learninglab.si.edu/collections/ancient-india/87L8V1PzDj5VYEF5#r.

Educator Spotlight: Transforming Teaching One Step at a Time

Tom Gray is a social studies teacher at Shaler Area Middle School in Glenshaw, PA. For several years, he has been looking for ways to inspire curiosity, problem solving, and critical thinking with his eighth-grade students. Over Tom's 19-year teaching career, he's tried many different teaching methods—lecturing, memorization, group work, project-based learning—all with some success, though he still worries whether his students are developing the skills they need.

Tom faces a couple challenges. First, he has trouble finding trusted historical sources for students to use in class and at home for research. Second, he wants to find meaningful ways to integrate technology into his instruction because of his district's recent investment in tablets for the students. And he wants students to be excited to learn!

When I started, it was all about putting together a lesson and sharing my knowledge with students. Today, we are guiding students to make their own discoveries and to be more actively engaged. I want students to think on their own. This is a great platform for doing that.

As a member of the first cohort of teachers, Tom used the beta version of the Lab and was eager to try it out. First, he integrated Lab resources into PowerPoint presentations, using paintings and photographs to illustrate historical topics. While he was happy with the quality and authenticity of the historical images, he wanted to take fuller advantage of everything the Lab had to offer.

Later in the year, Tom selected portraits of Andrew Jackson that he asked his students to analyze. Students compared and examined symbolism, choosing one portrait for an 1824 campaign poster and explaining their reasoning. They used the Lab's hotspot feature to mark the evidence they found in the portrait's details.

Tom says, "When I started, it was all about putting together a lesson and sharing my knowledge with students. Today, we are guiding students to make their own discoveries and to be more actively engaged. I want students to think on their own. This is a great platform for doing that."

By the end of the school year, Tom's students advanced to researching images in the Lab that they used to create short videos about historical events that reflected their point of view.

This study revealed that in some cases, teachers directed students to use the Lab search function for a "scavenger hunt" to find digital resources that exemplify a theme, or had students create collections of resources representing themselves (an engaging warm-up activity). Note, however, that some teachers in the cohorts engaged students in activities using paper printouts of Lab collections, because of their own comfort level or because computers were not available for each student.

When collections incorporate some of the Lab's tools, however, they enable a higher level of digital interactivity, which is explored in a later section.

Teachers' collections included digital resources, uploaded content, and metadata.

Digital Resources

The most often used digital resources (96% of the time in original published collections) are classified as "images." The term includes paintings, objects, photographs, documents, letters, scanned books, and Smithsonian educational content. Other categories of digital resources found in collections include "videos" (32%), "user-submitted websites" (25%), "user uploaded document files" (14%), "Smithsonian blogposts and articles" (7%), and "audio recordings" (1%).

The descriptive information (metadata) that appears in a resource's digital file has an impact on whether a teacher will incorporate it into a collection.

Cohort teachers were statistically more likely to use resources that contained these metadata categories: detailed description, historical and cultural contexts, and significance of the resources (see Appendix E for detailed discussion).

If these three types of metadata improve the usability of a resource, one may ask why all database items do not include them. Prior to the digital age, most of the users of museum collections were people who worked in museums. The records, organizational systems, and finding aids that these experts created served their needs, with such information as the physical dimensions and characteristics of the object, when the museum acquired it, and other data of primary concern to registrars. These needs remain, and the costs of modifying these records are great.

When the metadata includes comprehensive information such as historical and cultural contexts or why the resource is relevant, it may be because the museum has used the items in exhibits and programs and curators wrote informative label text for them. Another way some collection holders have improved metadata is by implementing strategies for writing metadata that increase the relevance for the nonspecialist user. As an example, for some items the National Museum of American History includes "general history" in addition to specific information about a particular object. Eight homefront war posters include such a statement, beginning with

"Posters during World War II were designed to instill in people a positive outlook, a sense of patriotism, and confidence."[13]

While one cannot conclude that this helpful information is the only reason that Lab users have already created 23 collections with seven of the eight posters, their popularity does suggest the importance of contextual metadata. The formidable costs of adding useful descriptions for each resource in such a vast repository could be reduced by identifying types of resources of greatest interest to educators and writing general descriptions that apply to all examples. Such actions would greatly increase the accessibility and value of museum collections for educators, students, and even the general public.

For more examples of varying metadata, see "Lab Resources with Varying Metadata" (Appendix D); to see how resources with different metadata were used by the cohorts, see "Online Museum Resource Metadata: Implications for Museum and Teacher Educators" (Appendix E).

Uploads

The Lab enables users to upload directly or insert via a URL their own resources and items from third-party sites into the collections they author. The Smithsonian included this functionality in the Lab based on teachers' requests, and it is a significant aspect of customization that the Lab offers. The collections chosen for further analysis were published original (not copied) collections not authored by Smithsonian staff members.

This study analyzed 217 randomly selected collections that contained 1,291 user-uploaded resources, representing 43% of the overall resources within these collections. Uploaded resources ranged from 1 to 76, with an average ± standard deviation of 14 ± 15 and a mode of 5, per collection (Appendix A). Review of uploads indicates that users added the following types of content to their collections:

Types of uploaded content (in order of frequency; see Figure 6):

1. images
2. website links
3. documents
4. info/text
5. web links to videos
6. worksheet or activity created by user
7. lesson plans or teaching strategy
8. quiz questions
9. sorting activity using tool

13. See http://s.si.edu/2zEj6pF.

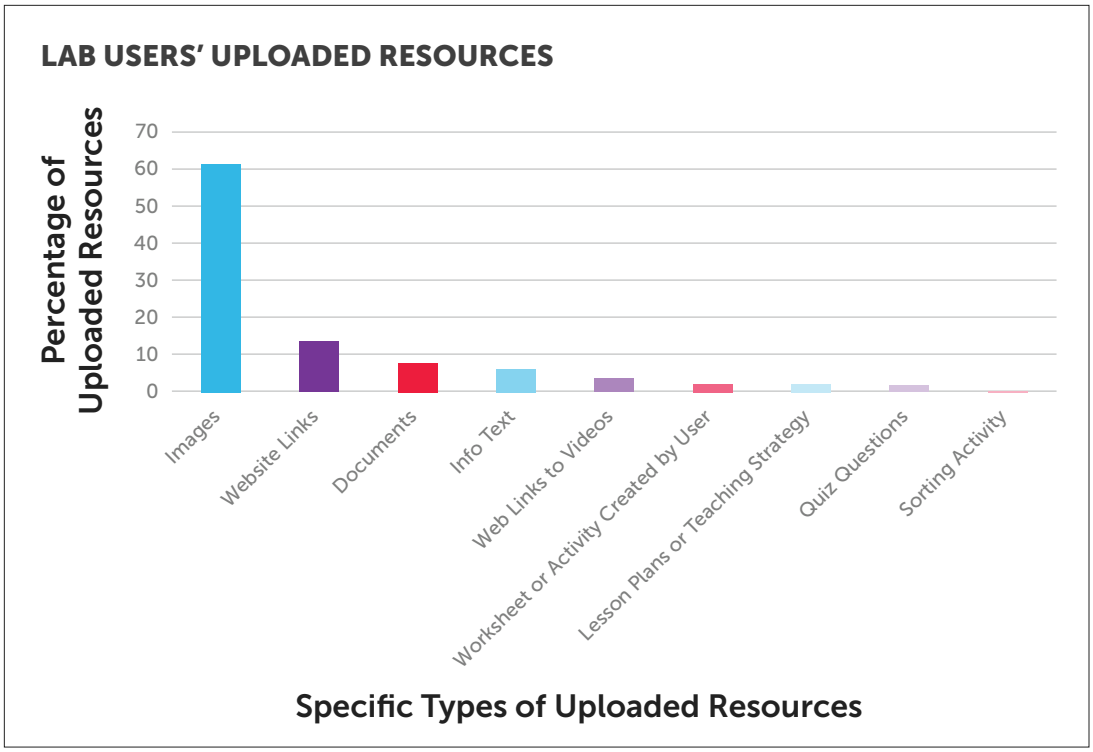


Figure 6. There were 217 Lab collections analyzed containing a total of 1,291 uploaded resources.

Examining the actual uploads shows that the most frequent upload, the image, is a broad category. Most often, the uploaded item comes from the Library of Congress, the National Archives and Records Administration, or another government agency such as the Environmental Protection Agency, as well as a few commercial sites such as auction houses and encyclopedias—indicating that these uploads augment the Smithsonian content (Appendix A). This category also includes examples that seem to be about convenience, such as the creator's personal photo of an exhibition (much faster to include than searching for or requesting one), Smithsonian images that are not accessible in the Lab database,[14] and screenshots made from other sites as a substitute for a link with a correct citation. The category "documents" often included primary sources such as the Gettysburg Address. The absence of citation proved to be such a common problem (note that 40% of the collections analyzed here lacked proper sources), that the Smithsonian developed a citation tool in the Lab in the summer of 2017 (Appendix A). With greater use of digital resources, tools to ensure compliance with the Smithsonian Terms of Use, applicable copyright laws, and general digital citizenship, best practices are increasingly important.[15]

14. Note that not all Smithsonian digital files are available in the Lab. Many such images can be found on the Smithsonian's many websites or are excluded from public access due to certain restrictions outlined in Smithsonian Directive 609: https://www.si.edu/content/pdf/about/sd/SD609.pdf

15. This citation feature also supports the International Society for Technology in Education's Standards (ISTE) for Teachers and Students in supporting digital citizenship practice. ISTE Standards for Students: http://www.iste.org/docs/Standards-Resources/iste-standards_students-2016_one-sheet_final.pdf?sfvrsn=0.23432948779836327; ISTE Standards for Teachers: https://www.iste.org/docs/pdfs/20-14_ISTE_Standards-T_PDF.pdf

Along with the citation tool, to promote good digital citizenship the Smithsonian took action to block the inclusion of "inappropriate" uploads. The Smithsonian Terms of Use[16] make its policies explicit, but the Lab's creators determined that extra steps would be necessary to protect children under the age of 13. While the vast majority of uploads are appropriate, some problems have occurred. A dedicated staff and digital volunteers screen each user-created published collection for suitability, reviewing its contents—including all annotations. Screening occurs daily, using a rubric to determine if content is off-topic, partisan-political, contains personal attacks or expletives, or is otherwise abusive, threatening, unlawful, harassing, discriminatory, libelous, obscene, false, pornographic, or an infringement on the rights of any third party. A case study completed in July 2017, Collections Screening in the Smithsonian Learning Lab Reveals Citation and Sensitive Material Concerns, reviewed the issues (Appendix F) and led to appropriate changes in the Lab (see Appendix C).

While a few uploads of commercial or mature content have been flagged, the most frequently encountered problem was lack of citation of proper sources, both by teacher-creators and by students using the platform. The new citation tool prompts the collection creator to add source material, and then formats it according to Modern Language Association, American Psychological Association, or University of Chicago style. Early results indicate that the tool is having the intended effect.

Digital citizenship best practices are increasingly important.

Metadata for Collections

The last type of content a teacher may add to a collection before publishing is metadata—an important one that is frequently overlooked. Metadata is crucially important because it makes it possible for other users to find and then use the collection. A drop-down menu of LRMI-related metadata fields (i.e., title, description, content/subject area, grade level, alignment to specific national education standards, resource types, and intended users) is used to label collections and has been available since the Lab's beta launch. Of the 2,336 published collections (up to March 31, 2017), 86% included a description, 50% "subject areas," and 77% "age range."

To encourage more users to add these metadata fields to their created collections, in mid-2017 the Smithsonian reduced and simplified the fields and added pop-up prompts after the user clicks "publish."

16. For more information, see Terms of Use: https://www.si.edu/termsofuse

Most collection creators publish a few collections, but some publish many.

The Lab includes both published and unpublished collections created by all registered users (including cohorts). The published collections represent 20% of the total number of collections. Most users never publish collections, and some visit the Lab just to find individual resources. The value of publishing collections is that they become available to all users and discoverable through search engines based on the quality of the metadata added.

Survey responders keep collections unpublished for several reasons (Appendix B, Q17):

- Needed more time to finalize the collection
- I did not know that I could publish the collection
- I created or modified the collection without intending to publish it
- For privacy concerns
- I did not want to replicate an existing published collection

Collection creators can still share unpublished collections with colleagues and students by providing the URL and through social media (Twitter, Pinterest, Facebook,

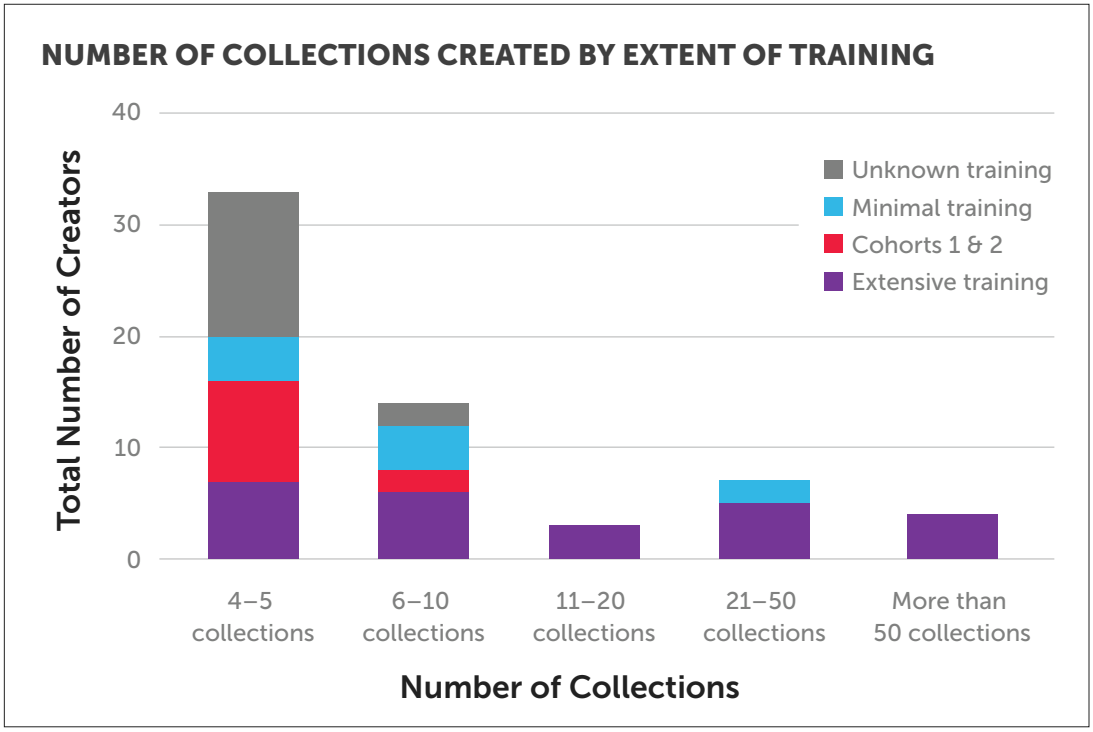


Figure 7. Most of the people in the extensive training category were Smithsonian staff or affiliated with the Smithsonian.

etc.). Sharing through channels teachers already use may have more value to them than publishing on a Smithsonian platform.[17]

Power Users

Many collections published in the Lab have been made by educators in roles other than classroom teacher. Those roles include museum educator, curriculum specialist, and master teacher or other specially qualified content developers. This suggests that the Lab's early adopters or most prolific creators may tend to be those who already excel in curriculum development and content knowledge. These are "power users," a term coined for those who published four or more collections. Power users come from a variety of backgrounds and experiences (i.e., museum staff, cohort teachers, teachers who attended a short professional development session, and others who attended no registered training). However, the majority of the prolific collection-creators—power users—were affiliated with the Smithsonian and had extensive training (see Figure 7).

Importance of Models

A crucial function of the collections made by museum educators, curriculum specialists, and master teachers is to provide classroom teachers with models of ways to use Smithsonian resources. Cohort coaches and Lab staff published more than 400 collections, initially for use in Allegheny County, often featuring content about the county (e.g., historical events) and Pennsylvania social studies standards. Smithsonian museum educators have published model collections for teacher workshops they conduct. Models may be used as is, or classroom teachers can modify them or emulate them in creating their own collections in the Lab.

Many teachers are unfamiliar with what museums collect, study, and make available in digital formats. They are unlikely to know all that is available, including resources such as documentary videos, oral histories, blog posts, podcasts, magazine articles, and online exhibits. Even social studies teachers who understand the value and uses of primary sources (e.g., documents) seldom know what to do with old machines, tools, uniforms, household equipment, and other artifacts from the past, let alone artworks. Further, it's one thing to view and consider objects in a museum exhibition, quite another to know how to use images of the objects for teaching.

Model collections also aid in understanding the educational uses of museum resources. Models created by coaches and Smithsonian staff are diverse, ranging from those that use museum resources to achieve standards of learning to others that demonstrate the application of museum-specific techniques such as observation strategies to still others that reveal how many teaching strategies can be applied to museum

17. Following is the number of times users clicked to Share via buttons, but this may not account for the total numbers of these shares (because someone could copy the URL and then paste it into one of those channels directly without using the Lab's buttons (data from January 2 to November 15, 2017). Using the buttons, they would most frequently share via a link and were almost three times more likely to share a collection than a resource.

Educator Spotlight: Curriculum Coordinator Finds Multiple Uses for the Lab

Jean-Marie Galing is a former elementary art teacher who now writes curriculum and creates professional development for more than 400 art teachers in Fairfax County, Virginia. She mentors these teachers in delivering the district's art program.

For nearly two years, Jean-Marie and the arts team had been writing new planning and pacing guides for all K-12 art courses. These guides include suggested artists and artworks to introduce a concept, build background knowledge, spark inquiry, and provoke discussions. While teachers have used art exemplars for many years, the team knew it was time to look for more up-to-date visuals that represent diverse artists, perspectives, and contemporary approaches to making art.

The guides let teachers concentrate on teaching rather than the time-consuming task of finding resources. They also provide models for high-quality instruction that focus on meaningful concepts while teaching art fundamentals and technical skills.

Teachers could use these resources to introduce a lesson, provide background knowledge, facilitate discussions, and pose essential questions.

Quality art instruction encompasses what, how, and why. While most teachers are confident teaching what (the projects students create) and how (the media techniques and skills), they are less confident in addressing why it matters—Why are you making this? What is your message? What is the concept or meaning in your artwork?

The Fairfax County team faced their own time challenges in creating resources for teachers, sorting through images and obtaining permissions, sometimes paying usage fees.

Jean-Marie learned about the Lab through an email announcing the launch. Later she watched a webinar offered through the National Art Education Association that introduced her to the Lab and its tools. She felt confident using the website—searching was easy, and the number of resources was "mind-blowing!"

She knew her teachers could use these resources to introduce a lesson, provide background knowledge, facilitate discussions, pose essential questions, propose research topics, play games, and generate ideas for art-making.

Once Jean-Marie realized the impact Smithsonian resources could have on her district's pacing guides, she started creating collections that are now published on the district's Elementary Curriculum Framework website, so all teachers can easily access them. More than 40 Lab collections are now being used by Fairfax County teachers, with more underway.

resources. Models may include the integration of essential questions, Project Zero Visible Thinking routines, and inquiry-based and other historical thinking approaches.

Collections made by museum educators,[18] may also serve their own goals such as:

- Presenting resources with instructional guidance reflecting museum expertise (e.g., "how to look at a portrait" or "the design-thinking process")
- Publishing content for workshops, online courses, webinars, and other professional development activities
- Providing a platform for collaborating on national initiatives such as National History Day or federally designated heritage month celebrations. Nine museums and cultural institutions created History Day collections in the Lab for the 2018 theme, each unique, but all supporting the larger effort.

Just as topical collections make it easier to *find* resources (see Project Objective 1), model teaching collections make it easier for teachers to understand *how to use* resources.

Teachers use the tools to encourage interactivity.

Both Lab users in general and the cohorts produced collections incorporating all of the tools. For both types of users, the most popular tools were info/text (to write annotations in a collection), image hotspots (to highlight and add text to an area of an image), and quizzes. As a result of user feedback, a sorting tool was added late in the research project and was more popular than the numbers reflect. The frequency of tool use is stated in Table 2.

TABLE 2. **FREQUENCY OF TOOL USE BY ALL USERS AND COHORTS 1 & 2 FOR ALL ORIGINAL PUBLISHED COLLECTIONS**

Info/Text	All Users	Cohorts 1 & 2	Quizzes	All Users	Cohorts 1 & 2
Resource text (%)	43	39	Resource quiz (%)	18	25
Standalone text (%)	15	15	Standalone quiz (%)	10	11
Image hotspots (%)	21	34	Sorting tool[19] (%)	2	10

Note: See glossary for definitions of terms used in table.

18. For eight case studies of Lab uses by Smithsonian museums and departments, see https://learninglab.si.edu/about/research.
19. The sorting tool, available only to cohort 2 and not until the third of their four sessions, received an enthusiastic response. Teachers liked the fact that this tool was not available on other sites and it was immediately evident how to use it.

Project Objective 3

Distinguish the types of supports needed by teachers having different access to and expertise with technology, skills in curriculum development, and experience using museum resources

Considerations involved in integrating the Lab into teachers' practice are the focus of this section, specifically:

- Understanding how teachers use the Lab
- Understanding the barriers to broader and deeper use
- Identifying and describing strategies that might be effective in overcoming these barriers

Basis of Findings

Information was gathered through classroom observations, pre- and post-workshop surveys, teacher interviews, focus group transcripts, coach and teacher logs, and workshop evaluations. In addition, the experience of teachers who had little to no training was captured through an online survey of registered users, evaluations from Smithsonian site-based workshops, and interviews with educators who published collections (Appendix A).

To capture the complex interplay of knowledge of content, pedagogy, and use of technology, this study used the Technological Pedagogical Content Knowledge (TPACK) framework (Appendix A, Figure 1A). These three types of knowledge are widely recognized as the core components of teacher practice and fundamental to effective instruction (Koehler, Shin, & Mishra, 2011; Koehler, Mishra, & Cain, 2013; Sobel & Grotti, 2013).

The findings of the interplay of the three domains may be broadly applicable, although the scope of the study was narrowed by grade levels, discipline, and geography of participants. Participants were middle and senior high social studies teachers in Allegheny County, Pennsylvania (including Pittsburgh). Allegheny County was selected because it consists of small, unincorporated districts with varied curriculum, technology, and training opportunities and it includes some urban, rural, and suburban schools (Appendix A).

Key Findings

Technology was not a significant barrier to use of the Lab.

Cohort teachers had varied access to technology in their classrooms, ranging from a one-to-one ratio of computers to a few computers shared by groups of students to no computers at all.[20] Teachers without classroom computers scheduled appointments in a computer lab or projected collections on interactive whiteboards. Just as the computer access varied, so did connectivity. Some teachers had limited broadband with inconsistent Internet access and poor speed. While teachers self-reported advanced skills in using technology, classroom observations documented a broad range of skills, from novice to expert.

Even teachers with the most limited technology found ways to use the Lab. One teacher with no Internet access downloaded a collection and projected it on a whiteboard, asking students to record answers on a worksheet. Another teacher posted a link to a teaching collection on Blackboard.com and assigned it as homework. Other teachers with a few computers in the classroom organized small groups that collaborated on building their own collections or completing activities. A few teachers, those with the most limited access and technology skills, downloaded and printed digital images to use during classroom discussions. These observations were confirmed by interviews with teachers and workshop surveys that reported overcoming technology challenges in various ways. Teachers not only adapted based on their situation and experience, they showed remarkable creativity.

Brief, effective training on the Lab and its tools is essential.

Participation in training—even a one-hour orientation at a conference—leads to a deeper use of the Lab and its tools. According to the survey, 30% of the teachers who attended training sessions used the tools as compared to 20% of the teachers who did not. The survey included both users who attended training (35%) and users who had no training (65%) (see Project Objective 2).

As mentioned, cohort teachers demonstrated a range of skills in using technology with their students. The first workshops focused on an overview of the Lab and how to use its tools. As a result of refinements to the Lab, the amount of time required to train teachers on the tools was reduced from several days during the

20. Computers in this context may also include devices such as tablets.

beta period to a few hours in the post-launch period (Zinger, Naranjo, Amador, Gilbertson, & Warschauer, 2017). The reduced training required was also confirmed in evaluations from Smithsonian site-based workshops and presentations at national conferences. The Lab enhancements included orientation videos, animations about the features, short video tutorials about the tools, and refinements to the platform and tools based on feedback (see Appendix C for a complete list). By reducing time spent on Lab tools, more time was dedicated to museum pedagogies and content knowledge, building Lab collections, and collaborating with colleagues—all highly valued by teachers as documented by workshop evaluations and interviews.

Professional development to train teachers on new technology is expensive and time-consuming and may conflict with teachers' more immediate goals. While it is essential to provide some training to ensure a deeper use of resources, training time can be further reduced and for some teachers eliminated. While many improvements have already been made, additional research-based enhancements are currently under development.

Teachers have limited time and seek integrated platforms and tools.

Teachers are already using other platforms and tools such as district learning management systems (LMSs), educational software applications for administration and assessment. Ideally, the Lab would integrate with these systems because they have quiz and student assignment tools. Integration would reduce duplication of effort and save time.

Some efforts have been made to integrate the Lab with these LMSs and other websites. First, Lab users can register with their Facebook or Google accounts. Second, an embed tool was added that allows users to post Lab collections on other websites or platforms (in the way that YouTube videos often appear on a wide variety of non-YouTube websites). By embedding a collection, users are able to access Smithsonian resources with a similar user experience as the actual Lab without visiting the Lab website itself. For example, for Veterans Day, a Virginia school librarian embedded a Lab collection on her school website about veterans' history and contributions.

One significant barrier to full integration with an LMS is sharing student data across platforms. Best practices in privacy and security define strict policies for sharing student data to protect children, especially children under the age of 13. Determining if it is possible to integrate systems and how to overcome these barriers merits further study.

Teachers need museum-specific content knowledge and pedagogy to use museum resources effectively.

Some museum resources are particularly valuable to educators because of their relevance to subjects taught in school. To be useful, resources need detailed contextual information (see Project Objective 2). This information tells you why the object is significant and provides background on the historical, scientific, or cultural context. Users would make even deeper use of resources if they understood how Smithsonian experts use them: how scientists analyze specimens, historians examine an artifact, or art historians interpret an artwork. These skills can be demonstrated by experts in short videos, interactive webinars, or simulations.[21]

Another deeper level of information is available by using advanced technology. For example, 3D images allow a closer examination of evidence—magnifying to see details and manipulating to view from different perspectives. These 3D images may be used to create virtual reality experiences. The Smithsonian Digitization Program Office and the National Air and Space Museum just completed a year-long project to create a virtual reality experience that takes users into the command module of Apollo 11. All these media resources will soon be discoverable in the Lab and can be added to teaching collections to provide deeper meaning about a resource.

An exciting example of cutting-edge curriculum-relevant resources is the work on human remains in Jamestown, Virginia, by Smithsonian forensic archaeologists Douglas Owsley and Kari Bruwelheide of the National Museum of Natural History. In partnership with Preservation Virginia, they have excavated seventeenth-century remains from the first English settlement in the Americas, and nearly 200 high-resolution images of these remains are available in the Lab. Students could use these images to make connections between forensic science and American history and to engage in authentic research, investigating important questions such as who came to Jamestown and what was their experience there. To make these images useful in a classroom requires richer context to create deeper understanding.

In a Lab collection on forensic anthropology, these images can be supplemented by videos of the experts showing how to analyze and interpret remains, a 3D image of a skull with hotspots pointing out significant details (Figure 8), and *Smithsonian* magazine articles telling stories about the people of Jamestown. Without these added layers, the human remains may not be usable or may be misinterpreted.[22]

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21. For examples, see the video *Defining Portraiture: How are portraits both fact and fiction?* https://learninglab.si.edu/resources/view/60783; archived Smithsonian Science How webinar, *Mummy Science with David Hunt* https://learninglab.si.edu/resources/view/1332544; and an interactive, *Written in Bone: The Secret in the Cellar*, https://learninglab.si.edu/resources/view/55194.

22. For examples of forensic anthropology resources about early America, see the website Written in Bone: Forensic Files of the 17th Century Chesapeake https://learninglab.si.edu/resources/view/55195#more-info; a video interview with Kari Bruwelheide, https://learninglab.si.edu/resources/view/5175#more-info; a *Smithsonian* magazine article about starving settlers in Jamestown Colony, https://www.smithsonianmag.com/history/starving-settlers-in-jamestown-colony-resorted-to-cannibalism-46000815/; and a 3D image of the remains of Rev. Robert Hunt buried at James Fort, https://legacy.3d.si.edu/explorer?modelid=1367.

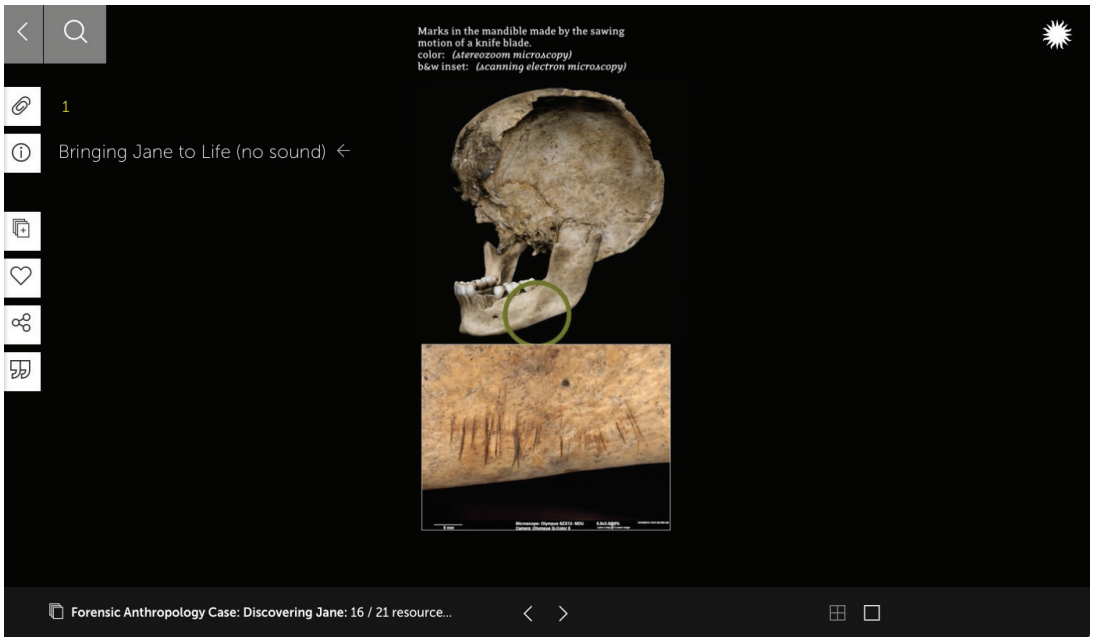

Figure 8. A 3D model helps viewers understand the forensic evidence.

Subject experts in different parts of the world have often worked together on research, and communications technologies are making it ever easier for educators to collaborate with them across great distances. In 2017, Hong He and Lingzhi Ma, at the Emperor Qin Shihuang's Mausoleum Site Museum (Xi'an, Shaanxi Province, China), Xidian University (Xi'an, Shaanxi Province, China), Yongying Dong at the School of Foreign Languages, the Freer Gallery of Art and Arthur M. Sackler Gallery, and the Smithsonian Center for Learning and Digital Access (both in Washington, DC) authored teaching collections on the sculptures representing the warriors of Emperor Qin Shihuang, the first emperor of China. The curators ensured fidelity to the latest research and the educators applied inquiry methods and standards. The Mausoleum provided high resolution images of the terra cotta warriors and the tomb complex and the Freer|Sackler added digital resources about subsequent dynasties. All this evidence is now available in six collections in the Lab and contextualized with the latest research, much of it currently unavailable in English publications. Together, these collections provide deep insights into ancient Chinese religion, history, and culture and align with U.S. standards of learning.

Connecting familiar classroom practices to museum digital resources is essential.

From the very first cohort workshop, teachers emphasized the need to focus on content standards and strategies for using museum digital resources in their classrooms. Unless teachers understood the relevance to their classroom practice, they were unwilling to commit the time and effort required to use the Lab. Based on teacher

feedback, professional development was restructured to focus on historical thinking skills and using the Lab to address them. With this focus, the emphasis switched to content knowledge and pedagogy: the evidence historians use and how to analyze it.

However, even with this focus on historical thinking, teachers needed guidance and models on how to work with museum collections. Many of the teachers were familiar with text-rich resources from the Library of Congress and National Archives and Records Administration. What is different in the Lab is that many resources are images of objects—artifacts, specimens, and artworks—not texts. For example, what can we learn about Abraham Lincoln from his personal possessions?[23]

All of the teacher workshops were held at the Senator John Heinz History Center (a Smithsonian Affiliate museum in Pittsburgh) and most included exhibit tours and curator demonstrations, which were some of the most popular sessions, according to workshop evaluations. In addition to in-person workshops, cohort teachers also participated in online interactive sessions with Smithsonian experts, including curators, historians, and educators. One of the most popular online sessions was with Briana Zavadil White, an educator at the National Portrait Gallery. During her session, Briana modelled strategies for looking at a portrait and sculpture of Rosa Parks and then applied these same strategies to other portraits of Civil Rights leaders. Similar online sessions were offered for looking at artworks, artifacts, archival documents, satellite images, and photographs.[24]

Another way to strengthen pedagogy is to make connections to research-based strategies such as asking essential questions, using Visible Thinking routines,[25] and applying research skills. In some cohort sessions experts modeled these strategies: A museum educator led a discussion using Visible Thinking routines with artworks, an archivist applied research skills to the examination of documents from a Pittsburgh family that survived the Holocaust, and a curator discussed how she crafted essential questions for an exhibit. They modeled pedagogy of how to use museum resources for deeper understanding. The impact of this modeling was apparent in teachers' progression in using museum resources in their classrooms. At first, museum digital resources were often used as illustrations in presentations, with images complementing the text, much like a textbook. Over the year, teachers created teaching collections that incorporated inquiry strategies, and by the end of the year a few of the teachers had their students conducting independent research projects using the Lab (Figure 9).

23. See archived webinar, *Abraham Lincoln: An Extraordinary Life*, https://www.youtube.com/watch?v=yvwuHlGx0o4&index=2&list=PLFGZwzyPnxTuvjvJJ6Z-VkcHW7Yy670-k

24. https://youtu.be/cMQtXIhTBns; https://www.youtube.com/playlist?list=PLFGZwzyPnxTtoKLqt1nLvRP2-JnZs8cB8

25. Visible Thinking is a flexible and systematic research-based conceptual framework that aims to integrate the development of students' thinking with content learning across subject matters. It was originally developed at Lemshaga Akademi in Sweden as part of the Innovating with Intelligence Project, and focused on developing students' thinking dispositions in such areas as truth-seeking, understanding fairness, and imagination. It has since expanded its focus to include an emphasis on thinking through art and the role of cultural forces and has informed the development of other Project Zero Visible Thinking initiatives, including Artful Thinking and Cultures of Thinking. http://www.pz.harvard.edu/projects/visible-thinking Many museum educators have integrated these routines into their practice (Ritchhart, 2007).

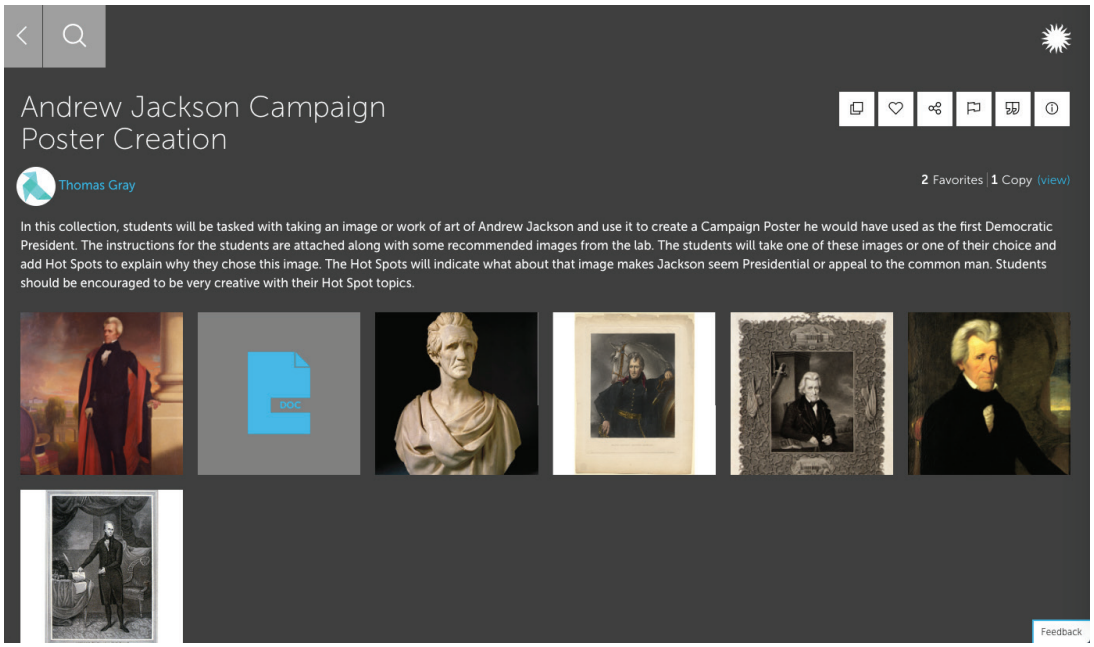

Figure 9. As described in Project Objective 2, Thomas Gray progressed from using museum images as illustrations to evidence students used for analysis.

Lack of time and knowledge of instructional design are serious barriers to teachers creating original content.

All of the cohort teachers created collections in the Lab, but they varied greatly in how many they produced, ranging from 2 to 14 collections (Figure 7). Most of the teachers made their collections during the workshops and only a few continued to make collections after the training was completed. When asked about continued use, the teachers answered, "I don't have time."[26]

One of the problems, as previously mentioned, was the time required to find resources. While teachers were usually successful in their searches (80%), searching took too much time, and they often found too many, too few, or irrelevant resources, thus requiring additional effort. Moreover, the Lab search engine, unlike other platforms teachers already use, is unable to rank results based on previous queries or crowdsourced popularity. Even when teachers found resources, many were without information (metadata) that would make them useful for classroom instruction (see Project Objectives 1 and 2).

Topical collections made by the Smithsonian or school district curriculum experts save time by eliminating the need to search for resources. As part of the project,

26. These are comments from cohort 1 only. Post-workshop collections for cohort 2 were not analyzed.

two instructional coaches worked with cohort teachers in their classrooms. These coaches created almost a hundred topical and teaching collections based on teacher requests, which were widely used by cohort teachers. In addition, Smithsonian staff offered a session on advanced search tips and created a document with suggestions. Informal classroom observations documented in coach logs and teacher implementation logs suggest that building a teaching collection takes considerable time. Workshop evaluations and focus group comments confirmed that teachers valued time during the professional development to work on them. While this project uncovered many aspects of the search experience, less is known about the process of creating a collection.

Limited time is a significant barrier, but not the only one. Teacher preservice and continuing education professional development is largely focused on implementation of instruction, less often on instructional design (Handler, 2010, p. 32, 37). Instructional design is a specialized skill that is the focus of district curriculum coordinators and the passion of some master teachers (see Project Objective 2). Working directly with university preservice education programs, district curriculum specialists, and master teachers on building teaching collections that model best practices in instructional design may be an effective strategy for creating original content.

Building teaching collections that model best practices in instructional design may be an effective strategy for creating original content.

The creation of topical collections, discussed at length in Project Objective 2, is another necessary support to save time. Smithsonian staff polled cohort teachers to determine the most important topics and museum staff created general topical collections with the most useful resources on—as one example—the Civil War, as well as more focused ones on its subtopics like uniforms, photographs, battles, letters, and songs. These topical collections range in number of resources from a few to almost a hundred, varying by topic and resources available. Yet, they are relatively simple collections to build. Currently, there are 87 Civil War collections in the Lab (as of November 6, 2017).

One of the supports built into the Lab to save teachers time is the ability to copy a published collection and modify it. Copying a collection is easy and takes less than a minute. The online survey of registered users revealed that respondents who attended a training were more likely to copy a collection (47%) than respondents who had no training (15%). Although a teacher can use a collection without copying it, once copied, she can easily modify the collection based on students' interests or needs.[27] According to the survey, users who attended training were more likely to modify the copied collection (30%) than users who did not attend a training (7%).

27. Whenever a collection is copied, the original author is always able to see who copied the collection. Further, the copied collection always links back to the original.

Users modified collections by adding or deleting resources, revising the textual information, adapting the quizzes and discussion questions, or creating their own activities (Appendix B, Q15).

Copying and modifying collections has greater value than just saving time. Users stated that the purpose of these modifications was to better align with their own curriculum and to meet their students' needs. A history teacher modified collections to reflect the history and culture of her community. A teacher uploaded photographs of Civil Rights events in Pittsburgh into a Lab collection. A middle school teacher collaborated with a special education teacher, modifying a collection for students with learning disabilities. These are examples of personalizing instruction. A language arts teacher made Lab collections to teach key vocabulary for her second-language learners to accompany required readings and to spark ideas for creative writing. A teacher who was developing vocabulary paired printed visual images with actual objects for her students within the autism spectrum. With appropriate metadata about the intended audience, these collections can be found by other teachers with similar needs.

Further analysis shows that collections were more likely to be copied if they had detailed descriptions (metadata) and featured tools. Only 7.7% of published collections have been copied (1,154 of 15,000), with an average of 2 $\pm$ 4 copies per collection (mean $\pm$ standard deviation), with most collections only being copied once (mode), and with a range from 1 to 93 times. Copied collections as compared to uncopied collections were more likely to have detailed metadata: descriptions (94% copied, 84% uncopied), subject (53% copied, 33% uncopied), and grade level (58% copied, 34% uncopied). In addition, collections that used tools, such as the image hotspot tool, were more likely to be copied (43% copied, 21% not copied). These findings about the characteristics of copied collections are statistically significant and confirm the value of creating model collections that have full descriptions and demonstrate effective use of tools because they are more likely to be copied.

Various supports added to the Lab itself address the problems of time and knowledge of instructional design. Time-saving supports include topical collections and the ability to copy. Instructional design supports include users' ability to modify copies based on student needs. Because teachers trained were more likely to use these supports, onboarding features and simple tutorials are being developed for teachers who are unable to attend training. While all these efforts may result in teachers using the platform and its tools more efficiently, the greater benefit is effectiveness—deeper use of museum resources to personalize instruction.

Creating models that advance the integration of technology, pedagogy, and content requires expert collaboration.

An individual can look at the image of the Supernova Remnant Cassiopeia A (Figure 10) and immediately recognize its beauty, but it takes guidance from a team of experts—in technology, pedagogy, and content—to realize its educational potential. An interactives and game designer worked with a team that included an astrophysicist, a data visualization expert, and a science educator at the Smithsonian Astrophysical Observatory to create this simulation. Now one can take a virtual reality tour and fly through Cassiopeia while an astrophysicist narrates the experience. This simulation is part of a Lab collection further enhanced with images that explain the electromagnetic spectrum, an activity to take one's own pictures of the universe, a career spotlight about an astrophotographer, and images of other supernova remnants.

To create this collection required the integration of advanced technology, deep content knowledge, and innovative pedagogy—all the elements of the TPACK model.

Figure 10. A supernova is the brilliant point of light created by the explosion of a star that has reached the end of its life. This visualization, created from real data collected by a team of astrophysicists, computer scientists, and visualization researchers, captures that explosion in three dimensions across the full electromagnetic spectrum: X-ray data from NASA's Chandra X-ray Observatory, optical data from NOAO Kitt Peak National Observatory and the MDM Observatory, and infrared data from NASA's Spitzer Space Telescope.

Because this experience is so complex, a single collection may take months to develop and requires collaboration among digital and visualization specialists, scientists, museum educators, and game designers. One of the benefits of aggregating museum resources on a single platform is that it provides a way for professionals to collaborate on published collections. In addition, as our understanding of supernovas advances, the team can easily update and republish. To use some types of museum resources effectively requires a deep knowledge of technology, content, and pedagogy, making collaboration essential.

Technology now gives the public access to digital museum resources in ways never before possible, not only to access, but the opportunity to experience these resources more deeply by examining high-resolution images, 3D views, and virtual reality simulations, and by using special tools to enlarge or annotate images. But in order to use these resources effectively, especially in school settings, we need to simplify ways to find them, provide relevant content information to inform their use, and create models that demonstrate their value.

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Project Objective 4

Document students' experiences using teacher-created digital collections

Studies have examined how young people learn in museums, but there is limited research on how students learn using digital museum resources in their classrooms (Azevedo, Moos, Greene, Winters, & Cromley, 2008; Bull et al., 2008; Hernández-Ramos & De La Paz, 2009; Lindquist & Long, 2011). While the focus of this research project is on how teachers find and use digital resources and supports they need, this section examines what happened in classrooms when teachers used Lab collections with their students.

Basis of Findings

This report is based on an analysis of 58 observations and 15 student interviews in Allegheny County schools. During the beta period, 27 classroom observations were completed in middle schools; post-launch, 31 observations were done in high school classrooms. The 15 interviews were conducted during beta with middle school students. Methodologies used to collect, tabulate, and analyze data appear in Appendix A.

Classroom observations focused on student engagement, which is considered essential for learning in many studies documenting a positive correlation between student engagement and measures of student learning (Finn, 2013; Corrigan, 2013).

Different variables may have contributed to differences in levels of engagement observed during the beta and post-launch periods of the study:

- Observers in each year were different
- Students were in different grades, middle school and high school
- Teachers taught different grades and different social studies courses
- The Lab platform was in beta during the first year and post-launch in the second, when it included significant refinements

Key Findings

Students using the Lab were highly engaged.

Classroom observations showed that overall student engagement with the Lab ranked "very high" or "high."

> *I liked that it was hands-on and how you could, once you picked your artifact you could kind of add a hotspot, add information to it and then reflect on the artifact and how it worked, what the artifact's impact was.* —8th grade student.

There were some differences between the beta and post-launch observations. Post-launch with high school students, the rankings were somewhat lower, with more ranked as "medium" and a few as "low" (Figure 11).

The "very high" engagement findings were echoed in responses from the 15 students interviewed. All of these students remembered using the Lab in class and could describe the learning activity, even though some of the interviews were conducted 2 months after the lesson. Further, all the students interviewed said they would recommend the Lab to other people. A large number of students interviewed said they wouldn't change anything about the Lab and wanted to use it in class again the next year.

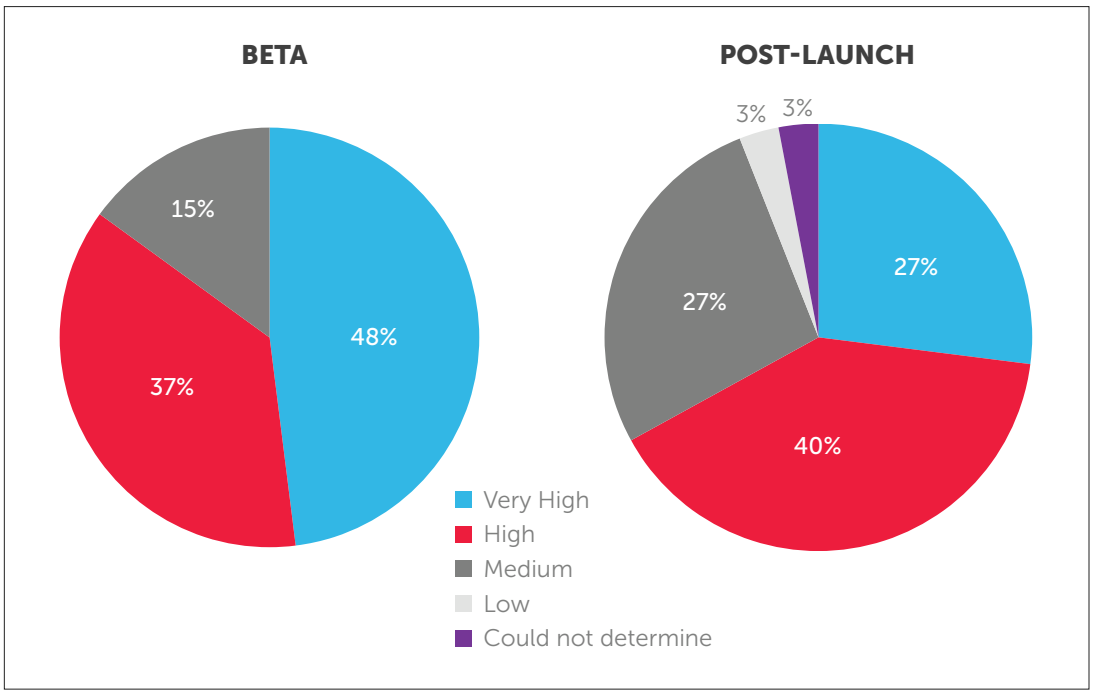


Figure 11. Overall student engagement based on classroom observations during beta and post-launch periods.

Figure 12. Students considered the idea of "helping your family" through images in a robot collection in the Lab. They identified shapes and forms, made inferences about robot function based on visual evidence, brainstormed possible ways that robots could help with household chores, and identified tasks they would like a robot to perform in their own homes.

Observations confirmed the Lab's versatility—with different devices, in different settings, and in different types of lessons—but not its optimal applications.

Classroom observations confirmed previous findings that teachers adapted the use of the Lab based on their own circumstances and methods of teaching. Regarding technology used by students, some worked on computers in their classrooms, others visited a computer lab, and some students viewed collections projected on a screen and answered questions on a worksheet rather than a computer. Regarding pedagogy, teachers used different instructional methods: whole-class direct instruction, small-group work, individual assignments, and in some cases, a combination. Consistent with earlier findings about how teachers used the Lab, few students made their own collections or used the Lab for independent research. For content, students used both museum digital resources and collections (Figure 12).

Given the variety of ways in which the Lab was used and the limited number of observations, further research is necessary to understand which circumstances result in optimal engagement.

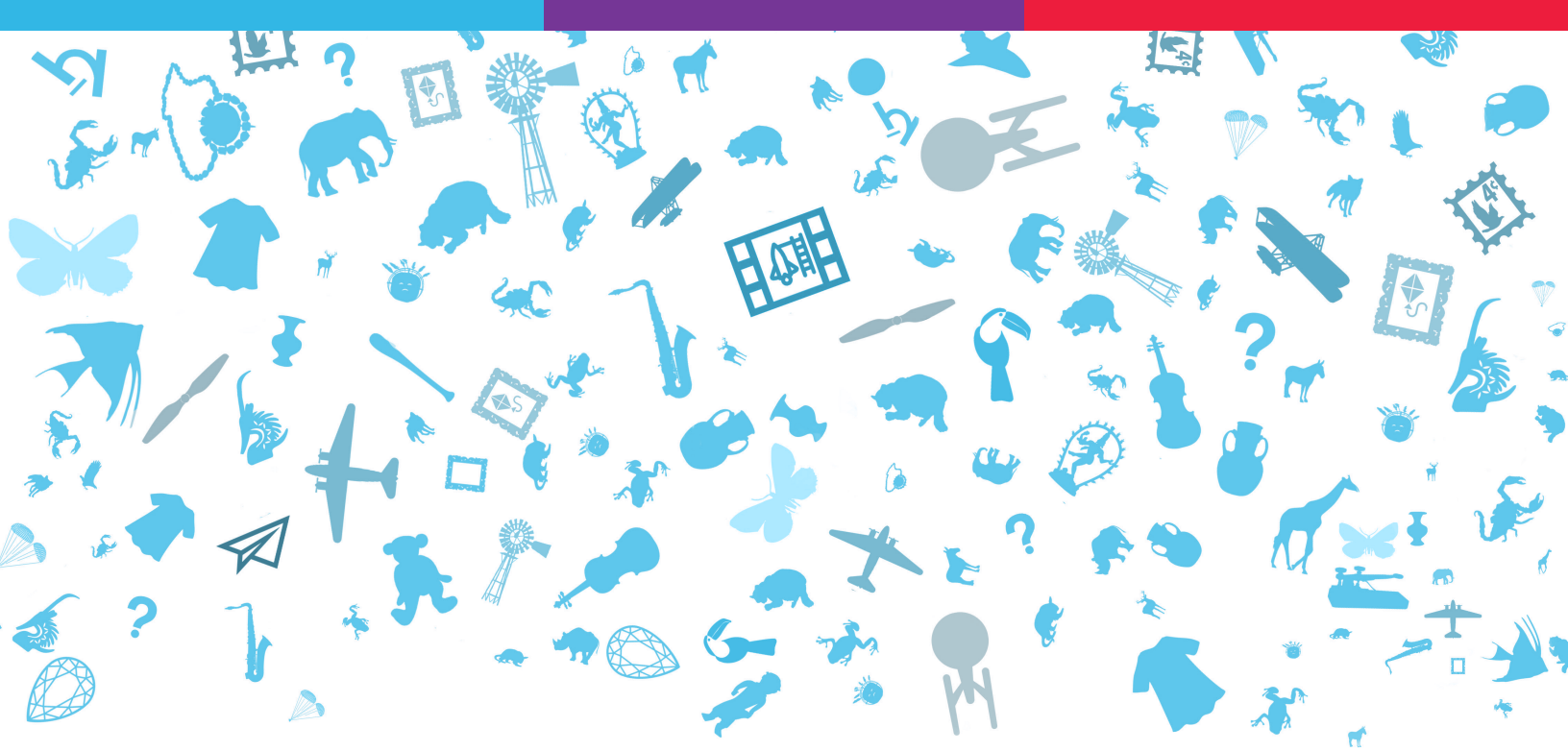
Students need some orientation to the Lab and may also need supports.

Generally, students were receptive to using the Lab and were positive during their experiences using it.

Classroom observations during beta and post-launch, however, documented challenges students encountered. Observers found that Lab users during beta had difficulty with registration, navigation, and use of tools. The interviews with 15 middle school students documented that the most significant issue was inadequate Internet speed and connectivity. Although the Lab can be used in many different ways, adequate bandwidth is essential for individual and small group projects.

Many students said they needed more instruction on how to use the Lab. There was no consistency in how the Lab was introduced to students nor in how often they had used it before the observation. Students interviewed during the beta period expressed confusion about the meaning of the icons and the purpose of the tools. Post-launch, students had difficulty working in small groups because the Lab was designed for individual usage and had no collaborative tools for small group work.

These observations further substantiate the need for supports (i.e., tutorials, onboarding prompts), for both teachers and students. As mentioned in the introduction, the Lab was designed for teachers to address their needs and requests. Now that teachers are using the Lab with their students, further research is necessary about the types of supports (at different grades and in different subjects) needed by students, including training on how to use the Lab.



Conclusion

In a world transformed by vast amounts of digital resources available online, teachers need better ways to find and curate authoritative resources. The goal of this study was to advance the use of digital museum resources in the classroom by understanding how teachers used these resources, the problems they encountered, and ways to overcome them. This research project took place over two years, culminating six years of work that led to the creation of the Smithsonian Learning Lab.

Educational potential of digital museum resources

Museum experts curate their resources based on what they consider most valuable, unique, representative, or illustrative of a particular place, time, or culture. They use artifacts, artworks, and specimens as evidence to answer important questions. Students can use digital museum resources to conduct similar authentic investigations, practicing the same methods and ways of thinking used by experts. But to achieve the full educational potential of these resources takes much more than simple access. Just as the museum visit is facilitated, how people encounter digital museum resources requires facilitation, in ways we are only beginning to understand.

How teachers found and used digital museum resources

One aspect of this facilitation is the metadata associated with a resource. Without metadata that is meaningful to the nonspecialist, users will be unable to find resources or understand the many ways they may use them. Our research clearly indicates that this metadata should include contextual information important for the general user, in particular, teachers and students, such as why the object was collected, its history, and tags that make it easier to find. The resource metadata serves the same function as an exhibit label—providing essential information about the object.

Writing comprehensive metadata is a time-consuming and expensive endeavor. Some museums have started experimenting with cost-effective strategies to enhance metadata. For example, some curators have written general descriptions for types of objects, and other curators have recruited subject-expert volunteers to write metadata that is reviewed before publishing, some museums have begun to experiment with automated mechanisms for developing descriptive metadata

(computer vision), and museum educators have selected high-interest resources for special attention. Even more consideration needs to be given to effective ways of enhancing metadata if a broader audience is to find and use digital museum resources.

Most users of the Lab simply view resources located by a search. Once they find resources, how do they curate them? Some make their own collections and others simply modify collections made by others. Most creators of original collections keep them private and a small percentage publish them so they become available to other users. Many creators enhance their collections by using tools to add annotations, text, and quizzes, and almost half upload, either personal content or items from other digital repositories.

The expertise of museum educators and curators can help teachers learn how to choose, assemble, and interpret digital museum resources. Rather than just selecting the first resource that a search engine finds, teachers would reflect on the most appropriate resource for the intended outcome, asking similar questions a curator might pose. Is the resource authentic? Is it worthy of further investigation? Will examination result in new insights? How does the juxtaposition of resources affect their meaning?

As part of this research project, museum educators and teaching coaches published collections that served as models to other teachers who used and copied them. These model collections raise new research questions such as: What metadata needs to be associated with collections so they can be found and effectively used? What are the essential features of quality collections? What skills do educators need to make these collections? What incentives would encourage more educators to become creators and share what they make? How do teachers customize model collections for their students? And most importantly: What is the impact of using digital museum collections on how children learn?

Overcoming barriers to optimal use

Teachers face barriers—in technology, content, and pedagogy—that they must overcome to make the best use of digital museum resources. Inadequate Internet access and insufficient quantities of devices are limitations, although teachers show creativity in adapting the use of the Lab to their particular situation. Another barrier is the time required to learn how to use a new technology, in this case, the Lab platform and its tools. Minimizing and simplifying training with intuitive design, embedded prompts, on-demand tutorials, and integration with other platforms that teachers and students already use would be beneficial. Finally, teachers need advanced research skills to search and find resources in academic databases such as the Lab.

Insufficient content about museum resources—both factual and interpretive information—presents another problem. Teachers choose resources that have richer metadata information that allows them to use resources in deeper ways. With rich metadata, teachers can progress from simply finding and assembling resources as presentation illustrations to more advanced uses. These more complex tasks include teachers guiding students to make observations, analyze sources, and draw conclusions. The progression continues as students themselves conduct independent research projects. Beyond the information available in metadata, teachers need to understand the methodology of museum experts: how an art historian looks at artworks, or how a historian verifies a source, or how scientists collect and analyze specimens. Technology offers many ways to share this deeper information through virtual reality experiences, interactives, online courses, animations, and other new experiences enabled by technology.

Pedagogy presents another barrier—teachers are uncertain how to use digital museum resources for instruction. While teachers may have experience visiting a museum, few have ever used digital museum resources in their classrooms. Some teachers address this problem by applying strategies they already know—asking essential questions, posing writing prompts, guiding close observations. The application of proven, research-based practices to digital museum resources increases the likelihood they will be used and their effectiveness when used. To make it easier for teachers to make connections between quality resources and best practices, templates for instructional approaches were added to the Lab for easy integration when building collections, model collections were created with strategies incorporated into them, and time was allowed to work on making these connections during professional development workshops previously described.

Limited time was the most significant barrier to using museum digital resources. What teachers valued most was time to work on collections during professional development workshops and the opportunity to collaborate with other teachers, museum educators, and curators while creating collections. More opportunities for collaboration need to be made available. Teachers come together in school and district trainings and professional conferences—potential settings for connecting quality digital museum resources, research-based practices, and curriculum standards. While each of the discipline-based professional associations have independently published recommended standards, all of them focus on some of the same essential skills—constructing knowledge by applying digital literacy and research skills to authoritative and authentic sources. These shared skills offer opportunities to integrate across disciplines using museum resources.

Educator Spotlight: Discovery and Creativity with the Smithsonian Learning Lab

Carole Geneix is director of teaching and learning for grades 6–12 at Washington International School in Washington, DC. An educator for more than 20 years, one of her responsibilities is organizing teacher learning groups that meet regularly to discuss problems of practice.

In her groups, Carole encourages teachers to use the Smithsonian Learning Lab because she believes it has the potential to expand teachers' practices and improve their research skills. She observes that many students and some teachers do not apply a rationale or criteria to their choices and may not select a resource with the greatest educational value. But Carole also knows teachers need to find things quickly. She wondered how teachers could use the Lab without being overwhelmed by so many choices.

Carole soon realized that if she wanted teachers to embrace the Lab, she had to embrace it herself. She started by creating collections about teaching and learning, using them whenever she made a presentation. As she used the Lab, she found it was a place for her own intellectual discovery and making meaning.

As she used the Lab, she found it was a place for her own intellectual discovery and making meaning.

For example, she found images of schools and report cards from the last century that initiated a deep conversation about assessment, comparing report cards and how they reflect school values. For another presentation, Carole needed to find a way to get science and language arts teachers to work together. In the Lab, she discovered an image of Leonardo da Vinci's drawing of a flying machine. She used this image with a slow-looking exercise (a Project Zero routine) and then led a conversation about interrelationships between the arts and sciences. Encouraged by the responses she has had so far, Carole is planning to next focus on multiple perspectives using cultural artifacts available in the Lab.

It is still a work in progress. She is happy to report that her school now has a new teacher learning group devoted exclusively to exploring and using the Lab. "This is only the beginning!" Carole says.

Realizing the potential

When the barriers are addressed, the results are remarkable. Museum digital resources present an exciting opportunity for teachers with a passion for designing instruction and the willingness to invest the time to develop their own ideas. These teachers find new ways to use museum resources that are fresh and unexpected.

The following examples show how two different teachers made compelling connections between art and math using digital museum resources (Figures 13 and 14).

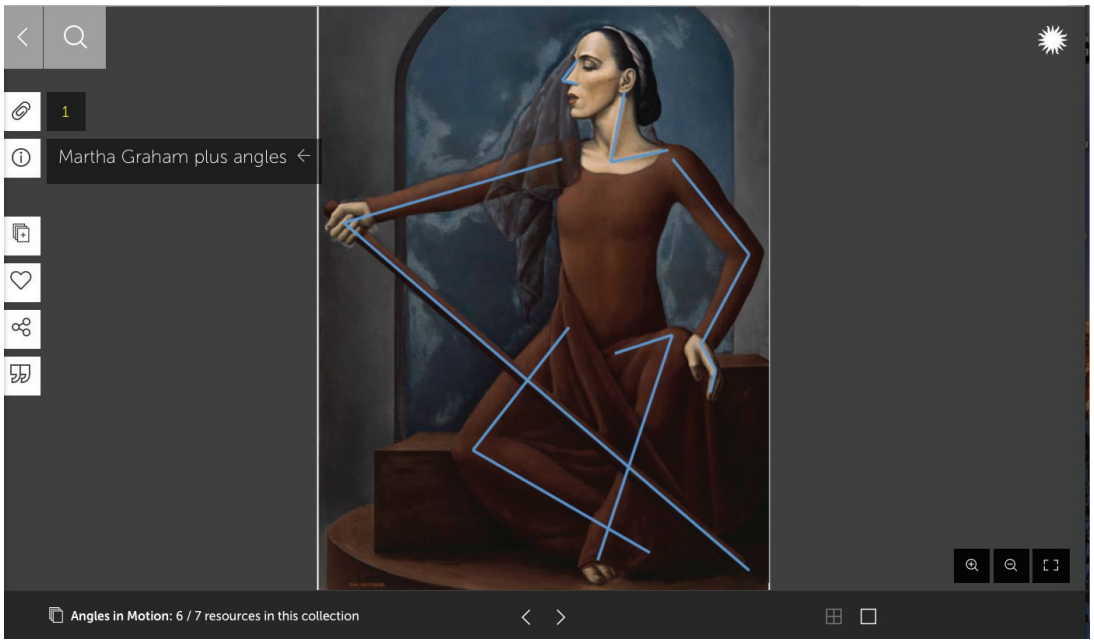


Figure 13. A middle school math teacher was inspired by a portrait of the dancer Martha Graham. To meet her school requirements to integrate the curriculum, she structured a series of questions and activities using a single portrait—examining angles, scale, and descriptive language (including math vocabulary).

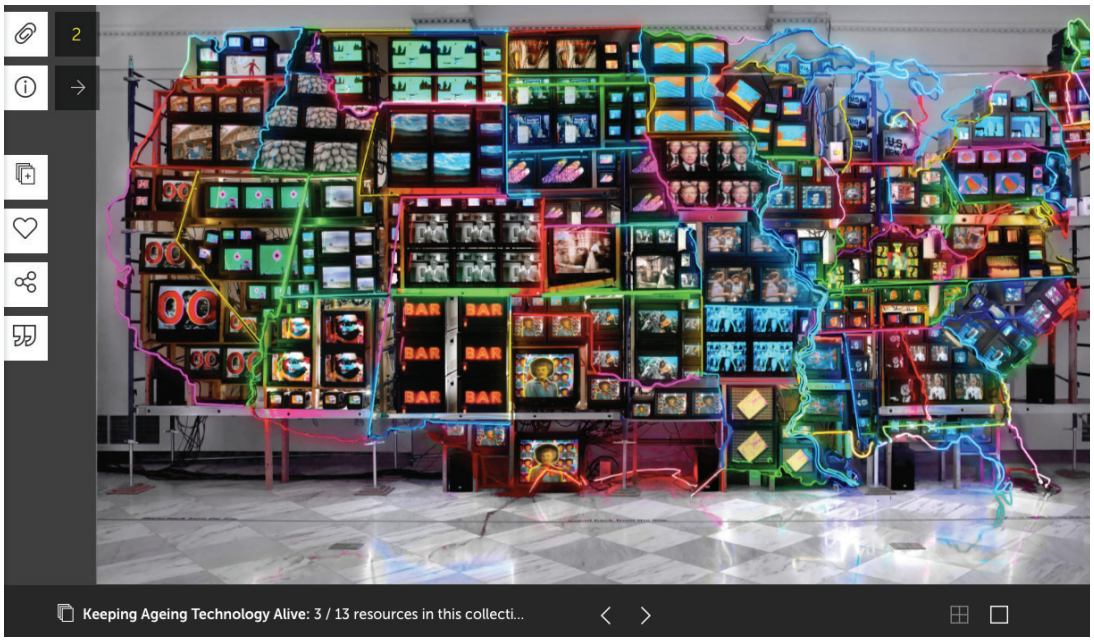
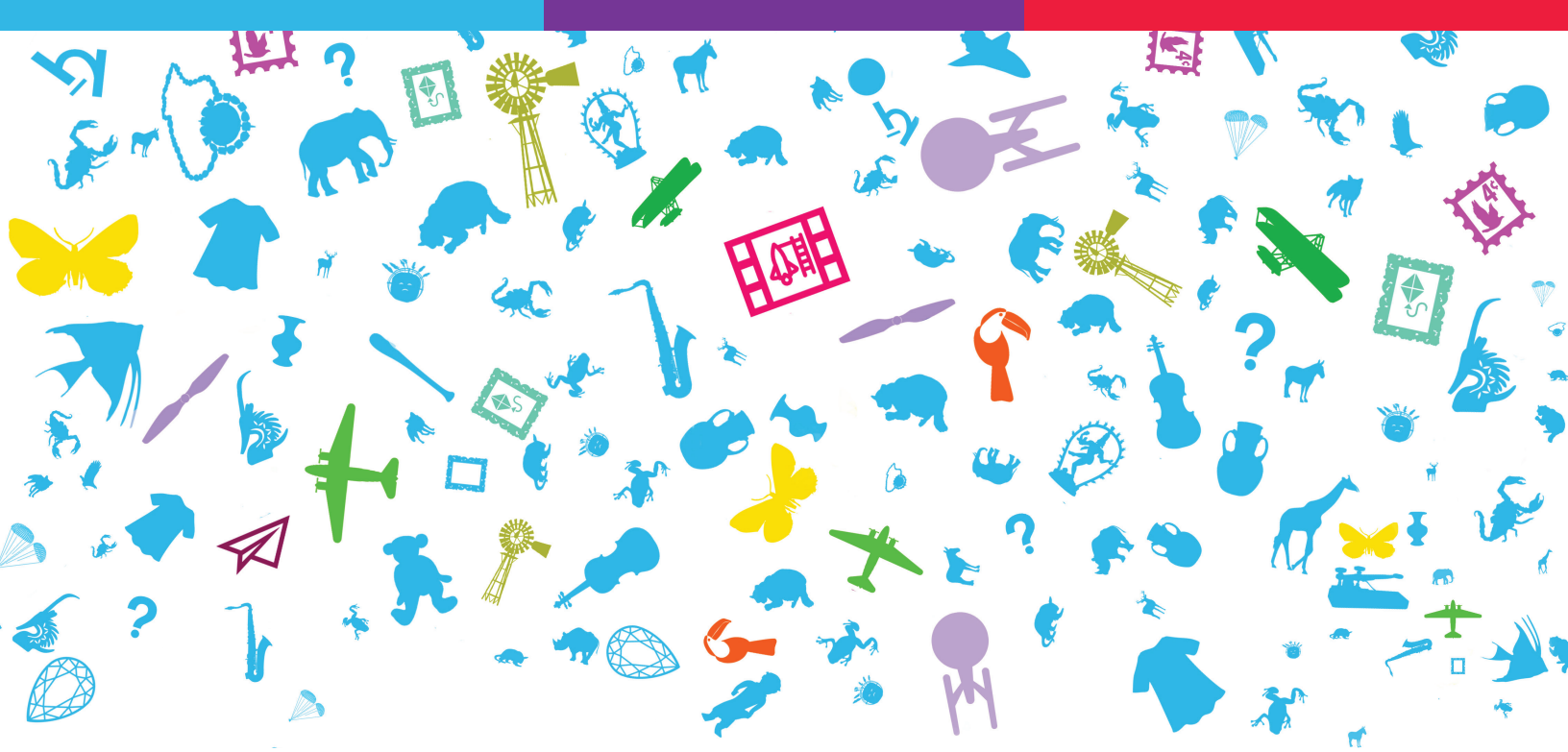


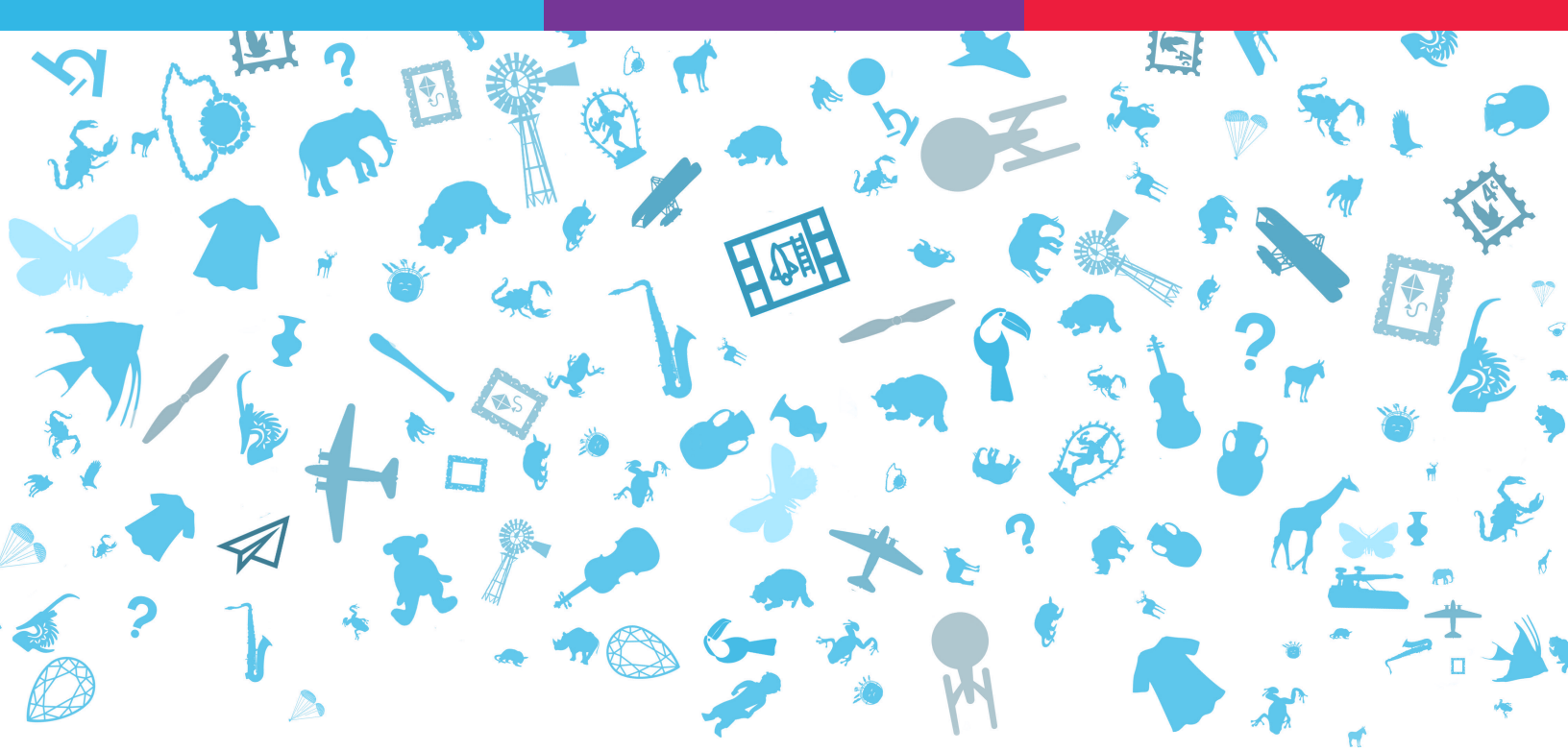
Figure 14. A high school math teacher built a collection about a video art installation that uses 50 televisions with cathode ray tubes, an obsolete technology. Students used graphing calculators to determine how many tubes would be needed to preserve the artwork for 50 years, considering the lifespan of a cathode ray tube and the storage requirements. Students then researched other technological innovations and their longevity and discussed the implications for our society.

Both of these teachers created delightful, original instructional experiences. Both reported that students were deeply engaged during these lessons, some students showing an interest in math for the first time.

Museums offer schools quality, curated digital resources that can deepen students' understanding of content along with their thinking and research skills. In order to realize the full potential of what museums have to offer, museums and schools need to work together. Both have expertise that is essential. Museums understand why their holdings matter and ways to analyze them to address fundamental questions. Schools understand what students need to know, effective instructional methods, and how to adapt instruction to meet students' needs and interests. Both museums and schools can benefit from this collaboration. Museums will learn how teachers and students make meaning using museum resources and possibly encourage a next generation of museum visitors. Educators will gain access to quality resources and expert guidance on how to curate and use them. And while the classroom observations of students were limited in number in this study, they suggest that when students use digital museum resources they are more engaged, an essential prerequisite for deeper learning.



PART II
Supporting Documents



Glossary

Learning Lab Terminology

Smithsonian Learning Lab

The Smithsonian Learning Lab, referred to throughout this report as the "Lab," is an online platform for discovering and using digital resources from the Smithsonian's museums, research centers, and the National Zoo.[28]

Resources

A resource is a multimedia asset, primarily (but not exclusively) a digitized item from the Smithsonian's holdings. It can be an image, video, audio recording, text, or website. Each resource contains descriptive metadata and can be joined with other resources to build a collection (see "metadata" and "collection"). Lab users can also add resources by uploading files from their own computers or adding links to external websites.

Collection

A collection is a group of resources that have been selected and aggregated by a Lab user. A collection may be published or remain unpublished. Published collections can be viewed, copied, and adapted by other users, while unpublished collections remain in an "unlisted" state and are only accessible by those with the specific website address. Collections tend to take one of several formats:

Topical Collection (without strategies)

A topical collection is a grouping of resources on a subject or theme. This type of collection is usually constructed to provide background information or context or to highlight specific resources and does not include instructional guidance.

Student Activity Collection

A student activity collection is a grouping of resources intended for direct student use.

Teaching Collection

A teaching collection contains resources with guidance on how to use the collection for instruction. It often follows the format of a lesson plan and includes a learning objective, materials needed, and step-by-step instructions for teaching.

Metadata

Metadata, or "data about data," provides organized information about resources and collections. For resources, metadata could include a title, description, creator, date, provenance, website link to the original source, and so on. In the case of a digitized item from the Smithsonian's holdings, metadata is the catalog record for that item.

28. See learninglab.si.edu for more information.

For collections, the creator of each collection can provide metadata to describe their grouping and help others understand how to use it. This information could include academic subjects, intended audiences, alignment to standards, and so forth.

Learning Resource Metadata Initiative

The Learning Resource Metadata Initiative (LRMI) is an initiative created by Creative Commons (CC) and the Association of Educational Publishers (AEP) to establish a common way to describe learning resources for education (Association of American Publishers, 2015). It is now administered by the Dublin Core Metadata Initiative.

Tag

A tag is a word or phrase that a user may add to the metadata of a collection. It improves search results by including terms not in the title or description.

Tool

A tool is feature available to collection authors that allows them to incorporate information or interactivity. Multiple tools can be used together with a single resource within a collection. The tools include:

Info/Text Tool

The info/text tool allows a user to write annotations in a collection.

Resource Text
Resource text is added to an individual resource.

Standalone Text
Standalone text is freestanding content added by a user. It appears in the same way (as a thumbnail) as other resources within a collection.

Image Hotspot Tool

The image hotspot tool allows a user to highlight a specific portion of an image with a box or target (overlaid directly onto the image). Users can also add their own titles and descriptions to provide context and information that become discoverable when others move their cursor over the box or target.

Quiz Tool

The quiz tool allows a user to create an interactive assessment for viewers of their collection.

Resource Quiz
A resource quiz is a question or series of questions added to a resource Student response options include true/false, multiple choice, short answer, long answer, or file submission.

Standalone Quiz

A standalone quiz is a question or series of questions within the context of a collection. It appears in the same way (as a thumbnail) as other resources within a collection. Student response options include true/false, multiple choice, short answer, long answer, or file submission.

Sorting Tool

The sorting tool allows a user to create an interactive sorting experience in which others sort or arrange a series of resources into categories or on a spectrum.

Terminology for Analysis

Bounce Rate

The bounce rate measures website user engagement by tracking whether or not users leave the website immediately after accessing a single webpage on a website.

Google Analytics

Google Analytics is a web analytics service offered by Google that tracks and reports website traffic and user behavior (Google Analytics, 2017).

Graphical User Interface (or U.I.)

The graphical user interface refers to the design of a web page with which a user interacts. Digital icons and other visual indicators on the page allow users to efficiently navigate and use the website.

Organic Search

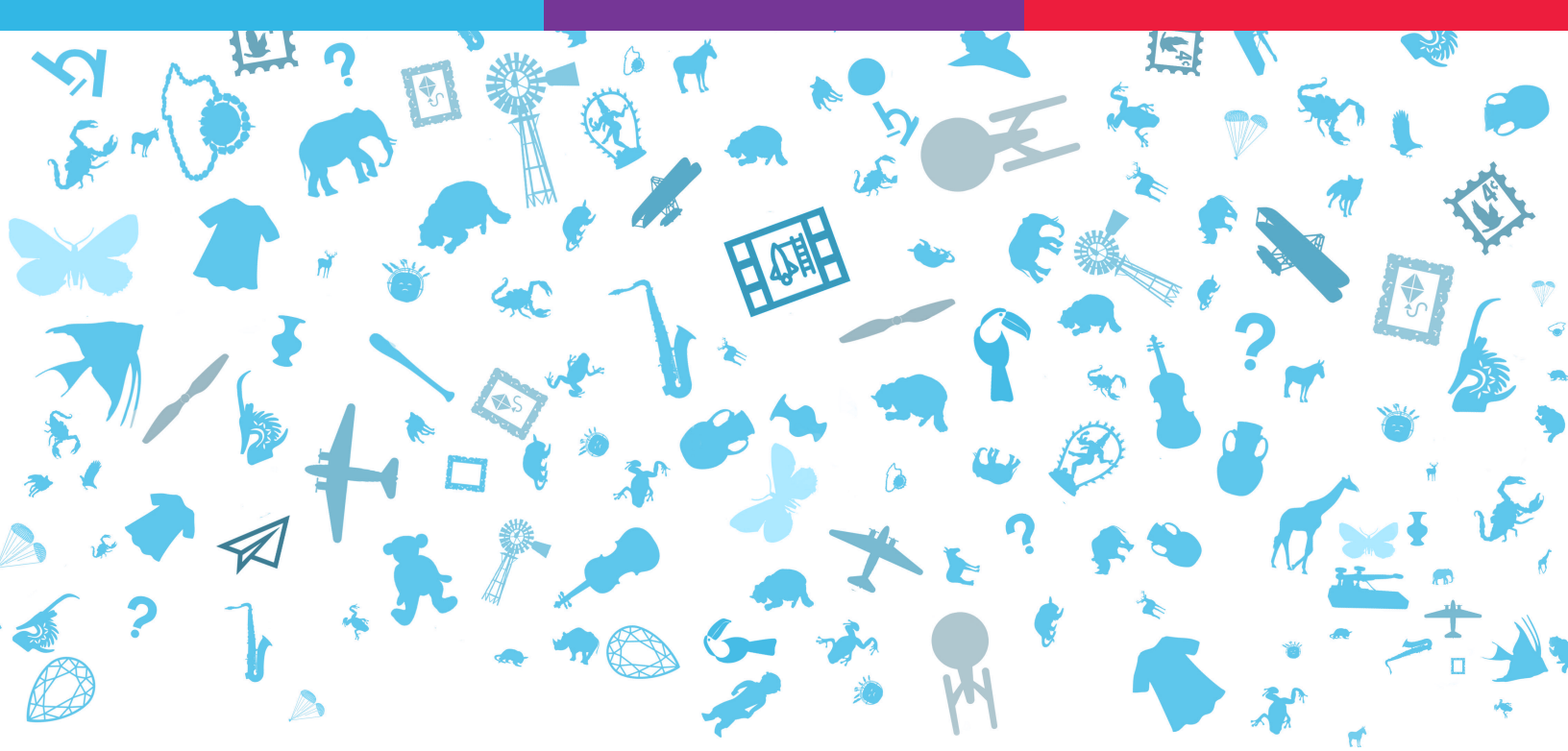
An organic search occurs when an Internet user performs a search query via a search engine. Search engine users can be directed to the Lab based on relevance of the search term to a specific resource or collection within the Lab.

Sessions

A session is a specific time frame during which a user interacts with a website. Often, it ends after 30 minutes of inactivity or when the user leaves the site.

Unique Page Views

Unique page views count the number of views webpages receive without including repeated visits within a single session.



Appendices

Appendix A
Study Instruments, Rationale, and Analytic Methodologies

Research examined more than 10,000 users' experiences with the Lab (through Google Analytics) and more detailed experiences of 407 users through surveys. Google Analytics data for all users for the Lab was compared with data collected for the cohorts participating in professional development (PD) sessions. The study examined the role professional development played in accessing resources and the quality of the learning experiences teachers create as a result of training. Research methodology included, among others, TPACK pre- and post-surveys, workshop evaluations, teacher interviews, focus groups, analysis of teachers' implementation logs, and different classroom observations (see below). Collections were analyzed for characteristics; a sample of 217 original published collections created by non-Smithsonian staff was used to analyze the user-uploaded resources. An analysis of how metadata contributed to teachers' selection of resources and collections was also conducted.

Selection of Teacher Cohorts

Middle and high school social studies teachers were enrolled in the study because both the discipline and grade level impact how teachers teach. While this study is specific to one subject area and level of instruction, the findings about the interplay of knowledge may inform future research projects in other subjects and at different grade levels. While the researchers narrowed the subject focus, they broadened the scope in other ways. They wanted to understand the use of the Lab in different contexts. Allegheny County, Pennsylvania, was selected as the research site because it includes a number of unincorporated school districts—urban, suburban, and rural. Teachers in Allegheny County followed the curriculum of 42 independent districts, have different access to technology, and have a broad range of experiences using museum resources. Both public and private schools were invited to participate.

Educators applied as school teams with two to three members. As part of the application process, team members described their experiences in curriculum development, access to and use of technology, and previous work using museum resources. Teachers chosen to participate reported a broad range of abilities in these three areas, and their access to technology ranged from no classroom computers and limited Internet access to a 1:1 student to computer ratio and a high level of broadband. While most of the participants selected taught social studies, teams also included librarians and media specialists to encourage collaboration and shared knowledge. Thirty-three middle school educators from 16 schools participated in cohort 1 (fall 2015 to spring 2016), and 34 senior high educators from 14 schools participated in cohort 2 (fall 2016 to spring 2017).

Methodologies

Google Analytics Report

- **Scope and timing:** All Learning Lab sessions November 2015–March 2017 (N=293,000 user sessions).
- **Rationale:** Identification of location, sources, navigation, searching, and engagement with the SLL by all visitors. Identification of potential challenges to visitor use of the SLL.
- **Methodology:** Quantitative analysis—counts and percentages.

Registered Users Survey

- **Scope and timing:** Sent to 10,000 Lab registered users over three waves in the Spring of 2017; (N=405 completed user surveys; margin of error at 6% confidence: 99%).
- **Rationale:** Identification of Lab registered user demographics, experiences, use, and engagement with the Lab. Identification of barriers and challenges to Lab use. Comparison of user who did and did not attend PD.
- **Methodology:** Quantitative analysis and Chi2 analysis. Qualitative, descriptive.

Lab Collection Dashboard (list of all collections published and unpublished)

- **Scope and timing:** Based on collections created between November 2015–May 2017; (N=11,499 total collections, N=2,336 published collections). Noted in the text if otherwise used.
- **Rationale:** Identify characteristics of user created collection. Identify characteristics of resources used in collections, including user-uploaded resources. Identify types of tools used by different types of users. Comparison of teacher used resources and "typical" resources. Compare collections of users who attended PD program and those who did not.
- **Methodology:** Primarily quantitative and comparative via t-test. Comparing different types or groups of resources of users in terms of characteristics of resources and tools used in collections.

Teacher Learning Lab Front Page Survey

- **Scope and timing:** Administered in February 2016 (N=16 non-Allegheny cohort teachers).
- **Rationale:** Report teacher identified impressions, feedback and challenges to navigation of the Learning Lab front page.
- **Methodology:** Qualitative, thematically coded. Used for triangulation and to contextualize Google analytics data.

TPACK Pre- Post-Survey

- **Scope and timing:** Administered at the beginning and end of each Allegheny cohort PD sequence (Fall/Spring) (N=26 for cohort 1 with pre-post scores, N=28 for cohort 2)
- **Rationale:** Determine if Lab Allegheny cohort teachers' knowledge changed through the course of the PD sequence, and if so what domains of knowledge.
- **Methodology**: Quantitative, pre- post- t-test analysis

Allegheny Cohort Focus Groups

- **Scope and timing:** Administered at the conclusion of each Allegheny cohorts' PD (N=5 focus groups per cohort).
- **Rationale:** Provide context and insight into teacher use, challenges, and potential future use of the Learning Lab.
- **Methodology:** Primarily qualitative, using descriptive codes to generate thematic codes and then theme them.

Face-to-face PD Teachers' Feedback

- **Scope and timing:** Administered 4 times per year subsequent each PD for Allegheny cohorts 1 and 2 (N=8 total administration of PD feedback).
- **Rationale:** Determine Lab Allegheny PD effectiveness, identify more and less effective components of the PD, determine teacher overall satisfaction. Identify teacher challenges to Lab use and how PD did or did not support overcoming the challenges.
- **Methodology**: Quantitative likert scale measures, analyzed via t-test. Qualitative responses coded descriptively and then thematically.

Coaching Support Feedback

- **Scope and timing:** Administered 2 times per year for each Allegheny cohort (N=4 total administrations).
- **Rationale:** Determine Lab Allegheny cohort coaching support effectiveness and types of support provided for teachers via coaching.
- **Methodology:** Quantitative likert scale measures. Qualitative responses. Primarily used for triangulation with face-to-face PD feedback.

Allegheny Cohort Implementation Logs

- **Scope and timing:** Administered monthly, for Allegheny cohorts 1 and 2. (N=6 administrations per cohort).
- **Rationale:** Identify if and how teachers were using the Lab. Identify barriers and challenges to teacher implementation of the Lab.

- **Methodology:** Primarily qualitative, using descriptive codes to generate thematic codes and then theme them. Counts use to determine change over time.

Online Google Hangout Feedback

- **Scope and timing:** Administered 3 times for year 1 Allegheny cohort (N=3 total administrations).
- **Rationale**: Determine Lab Allegheny online hangout effectiveness and support of teacher implementation of the Lab.
- **Methodology:** Primarily qualitative thematically coded.

Allegheny Cohort Researcher Classroom Observations

- **Scope and timing:** Over 3 dates in the Fall/Winter/Spring of each year (N=40 for cohort 1, N=23 for cohort 2).
- **Rationale:** Describe how the Lab was being implemented. Participating teachers selected for maximum variation of school settings, demographics, and backgrounds.
- **Methodology**: Open ended qualitative and descriptive. Primarily used to contextualize and triangulate findings related to barriers and challenges to use, as well as types of implementation by teachers.

AC Cohort Coach Observations

- **Scope and timing:** Through the course of the study period (N=90 for cohort 1, N=136 for cohort 2.
- **Rationale:** Identify the types of challenges faced by teachers in implementing the Lab. Identify the type of instruction and how Lab resources and collections are used to teach.
- **Methodology:** Qualitatively descriptively and thematically coded. Primarily used for triangulation with teacher implementation logs and post-PD survey data.

Coach Debriefing Meeting Notes

- **Scope and timing:** Conducted twice annually for each Allegheny cohort.
- **Rationale:** Identify challenges and use of the Lab by teachers.
- **Methodology:** Open ended, coded thematically, used for triangulation and as confirmatory PD feedback and researcher observations.

PD Agendas

- **Scope and timing:** (N=4 per Allegheny cohort, total of 8).
- **Rationale:** Determine the types of learning opportunities Allegheny teachers experienced during PD. Identify changes over time to meet teacher learning needs.

- **Methodology**: Qualitatively coded based on TPACK framework. Counts used to compare changes in PD teacher learning opportunities.

Allegheny cohort post year 1 use survey

- **Scope and timing:** Conducted April 2017 for cohort 1 teachers (N=7 respondents to survey).
- **Rationale:** Determine if and how Allegheny cohort 1 teachers used the Lab the year subsequent to the PD program.
- **Methodology:** quantitative; primarily counts.

PD team debriefing meeting notes

- **Scope and timing:** (N=4 per AC cohort, total of 8).
- **Rationale:** Determine challenges identified to the PD and to teacher use of the Lab. Determine if and how the PD changed to accommodate teacher learning needs.
- **Methodology:** Qualitative, thematic analysis.

Classroom observations focusing on students

- **Scope and timing:** Conducted for year one (30) and year two (30) by using a validated rubric to assess engagement.
- **Rationale:** Determine students' engagement with the Lab.
- **Methodology:** Quantitative analysis for engagement (results expressed in number and percentages).

Students interviews: In-depth interviews with 15 students from year one.

- **Scope and timing:** in-depth interviews with 15 students from year 1.
- **Rationale:** Determine students' engagement with the Lab.
- **Methodology**: Qualitative analysis for the students' interviews to extract themes and nuances.

Analysis for user-uploaded resources

- **Scope and timing:** Randomly selected 217 original, published non-SI users created collections with user-uploaded resources were analyzed.
- **Rationale:** Determine the counts and nature of user uploaded resources.
- **Methodology:** Quantitative analysis (results expressed in number and percentages).

TPACK Framework and Professional Development

This research project used the Technological Pedagogical Content Knowledge (TPACK) framework to capture the complex interplay of knowledge—content, pedagogy, and technology—emphasizing the intersections (Archambault & Crippen, 2009; Koehler, Mishra, & Cain, 2013).

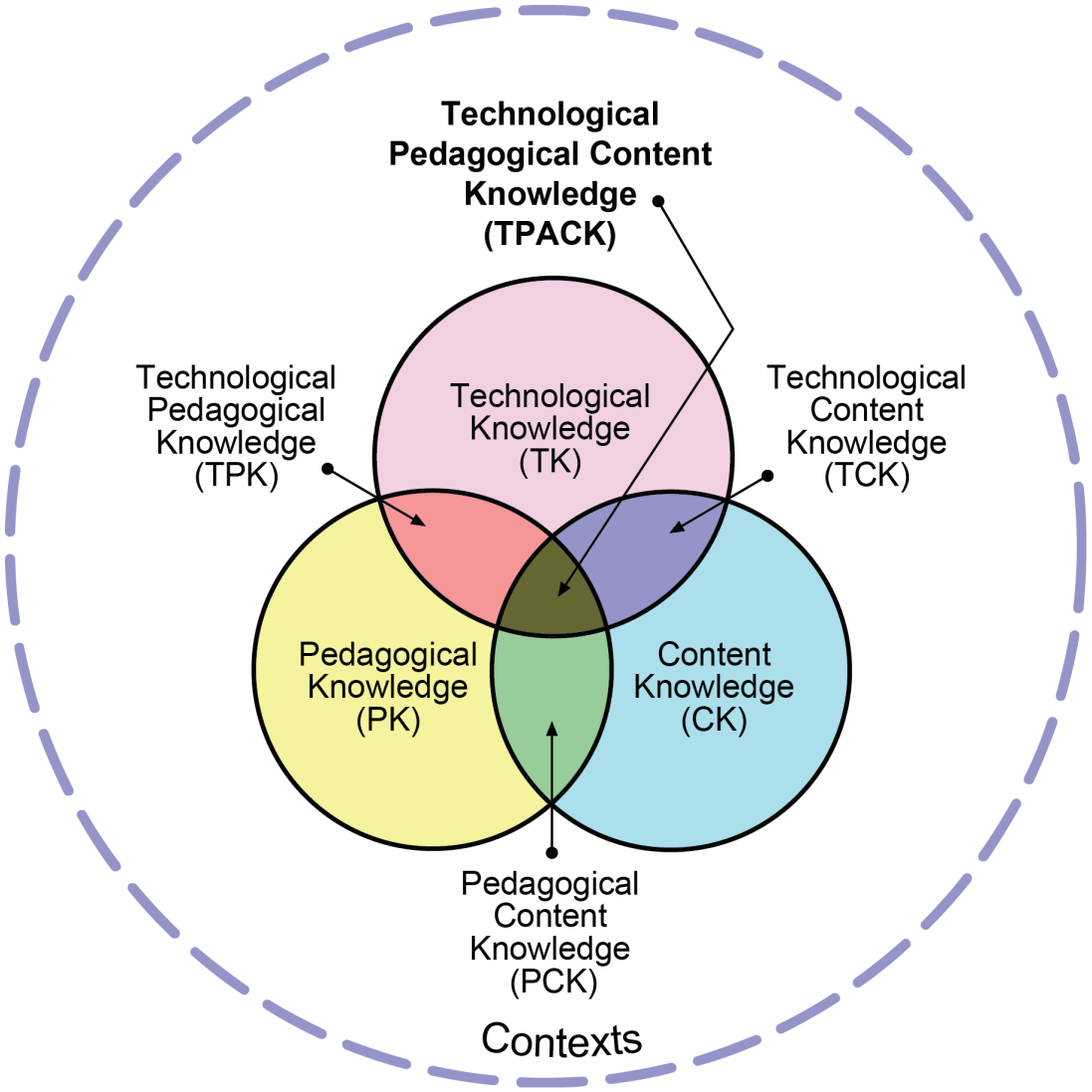


Figure 1A: The TPACK attempts to identify the nature of knowledge required by teachers for technology integration in their teaching.[29]

29. Reproduced by permission of the publisher, © 2012 by tpack.org

Educators in each cohort participated in four, full-day professional development workshops and had access to three live (or archived) online sessions. These training opportunities were scheduled throughout the school year, allowing for interactions every four to eight weeks. Teachers completed evaluations at the conclusion of each of the four workshops, reporting on problems encountered and recommending interventions. The workshops were planned using an iterative, design-based approach, with each of the four iterations refined based on survey and teacher interview feedback. All workshops were held at the Senator John Heinz History Center and included both gallery and online interactions with museum collections, and, in one workshop, the world history teachers also visited the Carnegie Museum of Art. Both in-person and online sessions were led by museum educators, curators, and archivists.

Instructional coaches visited each school four times during the year and kept logs noting how teachers used the Lab and any problems they experienced. Coaches created over one hundred model teaching collections and worked with teachers on making their own digital teaching collections, modeled lessons using them, and observed teachers' presentations and provided feedback.

Student Engagement Methodology

Sixty-one classroom observations were completed to assess student engagement experiences with teacher-created and mediated learning collections. The observation length was one classroom period with the entire classroom. Observations related only to student activities in which students interacted with the Lab on a device either individually or in groups. Activities from students interacting with Smithsonian content without using a digital device (e.g., students who used paper printouts of Lab content provided by the teacher) were not counted.

Beta period observations were made between February and May 2016. Participating teachers were first introduced to the Lab in the Fall of 2015. The sample included 33 classrooms of educators located at 18 schools in the Allegheny County, PA, area. Thirty-seven classroom observations were conducted; Out of these 37 observations, 27 fit the analysis criteria and were assessed for this report.

Post-launch observations were made between March and May 2017. Participating teachers were first introduced to the Lab in the fall of 2016. Thirty-one classroom observations were conducted. All of them were assessed for this report. The engagement-rating matrix contained five elements and one overall summary rating. Individual rating elements included:

1. **Positive Body Language:** Students exhibit body postures that indicate they are paying attention to the teacher and/or other students.
2. **Consistent Focus:** All students are focused on the learning activity with minimum disruptions.

3. **Verbal Participation:** Students express thoughtful ideas, reflective answers, and questions relevant or appropriate to learning.
4. **Student Confidence:** Students exhibit confidence and can initiate and complete a task with limited coaching, and they can work in a group.
5. **Fun and Excitement:** Students exhibit interest and enthusiasm and use positive humor.

The rating levels included:

- Very high (90% or more of the students exhibit engagement)
- High
- Medium (approximately 50% of the students exhibit engagement)
- Low
- Very low (10% or less of the students exhibit engagement)

Student Interviews (Beta Period)

To supplement the classroom observations, researchers conducted interviews with 15 students in grades 6 through 8 who were between 11 and 14 years of age. The goal was to document and evaluate student engagement with the Lab digital content and tools. The interview protocol consisted of sixteen open-ended questions detailing (a) students' experiences with Lab and feedback using the Lab, (b) students' experience with other types of websites used for learning, and (c) students' descriptions of how they learn outside of school. The interview subjects were selected using purposeful sampling/expert sampling. Students were enrolled in the sample only if they had used the Lab and had received parental consent.

Characteristics of User-Uploaded Resources and Citations

A random sampling of 217 Smithsonian Learning Lab collections were analyzed to determine the characteristics of user-uploaded resources and citations. The 217 random collections excluded collections created by Smithsonian staff, interns, fellows, and contractors, or museums affiliated with the Smithsonian. Overall, the collections were created by teachers and students in classroom settings, as well as Smithsonian museum workshop attendees, and the cohorts, in addition to general public users. Only collections that contained user-submitted resources were analyzed. The total number of user-submitted resources represented 43% (N = 1291) of the overall resources within the collections (N = 3002).

Citations

38% of collections (n=83) lacked one or more instances of proper resource citations. While some collections were missing one or two citations, some user collections contained no citations at all. This confirms the need for the citation tool recently implemented in Smithsonian Learning Lab, and should act as a catalyst for a dialogue with teachers and students to recognize the importance of properly cited material. Technically, 38% of collections could be considered "plagiarized."

Overall, the analysis found that of the 1,291 resources submitted by Learning Lab Users, collections contained the following nine types of resources (from greatest to least):

Images

- [N=795]
- primary sources—photographs, images of paintings, illustrative works—including those uploaded from other museums and Smithsonian museums and archives

Websites

- [N=177]
- URL links to external—and sometimes Smithsonian—sources

Documents

- [N=103]
- primary sources—such as the Gettysburg Address or Declaration of Independence; as well a poetry and writing samples for text reading and analysis

Info/Text

- [N=81]
- created using the standalone tool—information text that users created using the Info-Text tool

Video Websites

- [N=48]
- link to videos in YouTube (links to the video-sharing service)

Worksheet or activity

- [N=30]
- created by the user—activities that teachers created for students, graphic organizers, and worksheets for use in the classroom

Lesson plan or teaching strategy

- [N=29]
- formal lesson plans, as well as visible thinking routines and instructions

Quiz Questions

- [N=24]
- using the standalone tool—question annotations related to a collections' resources

Sorting Activity

- [N=4]
- using the standalone tool—an activity annotation requiring users to sort resources into categories

TABLE 1A. WHAT KINDS OF WEB LINKS DID USERS UPLOAD?

Website Source	Description or Example
Academic – U.S. state university	University of Maryland, University of Virginia, University of California – Berkeley, University of Cincinnati
Commercial	rboutlaws.com
Commercial – art gallery blog	A dot-com site selling artwork, burton morris.com
Commercial – artist's site	A dot-com site selling an artist's artwork, timokamura.com
Commercial – city promotion	Promotional content for a city, Next Pittsburgh
Commercial – education	Ducksters.com, Gale group, National Geographic
Commercial – file storage	File sharing sites
Commercial – historic newspaper article (adapted)	*Old Post Gazette*
Commercial – history	Explore PA History.com, History Channel, Popular Pittsburgh.com
Commercial – journalism	Bill Moyers.com, BBC, *NY Times*
Commercial – journalism – blog	Slate.com blog
Commercial – research site w/ academic partners	Chronozoom.com
Commercial – search engine	Google (images)
Gov – U.S. fed agency – EPA	United States Environmental Protection Agency
Gov – U.S. fed agency – FBI	United States Federal Bureau of Investigation
Gov – U.S. fed agency – LOC	United States Library of Congress
Gov – U.S. fed agency – NARA	United States National Archives and Records Administration

TABLE 1A. WHAT KINDS OF WEB LINKS DID USERS UPLOAD?

Website Source	Description or Example
Gov – U.S. fed agency – NARA et al.	United States NARA, ourdocuments.gov
Gov – U.S. fed agency – NASA	United States National Aeronautics and Space Administration
Gov – U.S. fed agency – NOAA	United States National Oceanic and Atmospheric Administration
Gov – U.S. fed agency – NPS	United States National Park Service
Gov – U.S. fed agency – USGS	United States Geological Survey
Gov – U.S. fed museum – USHMM	United States Holocaust Memorial Museum
Gov – U.S. state – historical society	Minnesota Historical Society
Gov – U.S. state – library/humanities	Connecticut Teach It
Gov – U.S. state agency – environment	New York State Department of Environmental Conservation
Nonprofit – encyclopedia	Wikipedia
Nonprofit – research consortium	Biodiversitylibrary.org
Nonprofit foundation – education	Poetry Foundation
Nonprofit foundation – educational media	PBS.org
Nonprofit foundation – history/archive	Gilder Lehrman Institute of American History
Nonprofit foundation – museum	Historic Jamestowne
Nonprofit foundation – museum/archive	Newseum
Nonprofit foundation – museum/historic site	Monticello
Nonprofit – education	TeachingHistory.org
Personal – education	Classroom/teacher's blog
Smithsonian	Smithsonian museums or archives' websites
Smithsonian Learning Lab	Smithsonian Learning Lab site
Social media	Flickr

TABLE 2A. WHAT KINDS OF IMAGES OR DOCUMENTS DID USERS UPLOAD?

Document or Image Source	Description or Example
Academic – historic atlas	Harper's Atlas of American History
Academic – international university archive	Institute of Historical Research – University of London
Academic – journal article	JSTOR, National Trust for Historic Preservation - Mesda
Academic – U.S. state university	University of Maryland University of Virginia University of California – Berkeley University of Cincinnati, University of Missouri – Kansas City, CUNY – NY, UMASS – Amherst
Commercial – art gallery	Gary R. Lucy Gallery
Commercial – artist's site	Kehinde Wiley
Commercial – blog	Slate, Glamour Daze
Commercial – e-book	Kindle
Commercial – e-commerce	Amazon, AllPosters.com
Commercial – education	National Geographic, viralnova.com
Commercial – encyclopedia	Encyclopedia Britannica
Commercial – file storage	File sites that point to images
Commercial – history	Gale Group, History Channel
Commercial – image site	Getty Images, Vintage Dancer
Commercial – journalism	CBS News, *TIME, Latin Magazine, New York Times, Cosmopolitan*
Commercial – journalism – blog	New York Times Magazine Blog
Commercial – journalism – historic	*Harper's Weekly, TIME* magazine covers
Commercial – science site	LiveScience
Commercial – search engine	Google (images)
Commercial – tourist	Google 360° Tourist Sites
Gov – international – environmental	Ecodatainforma (Brazil)
Gov – international archive	Berlin Government, Bibliothèque et Archives nationales du Québec
Gov – international museum	Louvre, Majdanek.eu, National Portrait Gallery (UK)
Gov – international state page	State in Brazil
Gov – U.S. city archive	City of Boston (MA)
Gov – U.S. city library	Levittown Public Library
Gov – U.S. fed agency – AOC	United States Architect of the Capitol
Gov – U.S. fed agency – CONGRESS	United States Congress
Gov – U.S. fed agency – EPA	United States Environmental Protection Agency

TABLE 2A. WHAT KINDS OF IMAGES OR DOCUMENTS DID USERS UPLOAD?

Document or Image Source	Description or Example
Gov – U.S. fed agency – LOC	United States Library of Congress
Gov – U.S. fed agency – NARA	United States National Archives and Records Administration
Gov – U.S. fed agency – NARA (DocsTeach)	United States National Archives' DocsTeach
Gov – U.S. fed agency – NARA et al.	United States NARA, ourdocuments.gov
Gov – U.S. fed agency – NASA	United States National Aeronautics and Space Administration
Gov – U.S. fed agency – NOAA	United States National Oceanic and Atmospheric Administration
Gov – U.S. fed agency – NPS	United States National Park Service
Gov – U.S. fed agency – U.S. SENATE	
Gov – U.S. fed agency – USGS	United States Geological Survey
Gov – U.S. fed museum – USHMM	United States Holocaust Memorial Museum
Gov – U.S. state – DCNR	State of Pennsylvania Department of Conservation and Natural Resources
Gov – U.S. state – historical society	Historic Northampton (MA)
Gov – U.S. state – library/humanities	State Library of Massachusetts
Gov – U.S. state agency – environment	New York State Department of Environmental Conservation
Nonprofit – encyclopedia	Wikipedia
Nonprofit foundation – educational media	PBS.org
Nonprofit foundation – historic site	Fort Pitt Museum, Historic Jamestowne, Colonial Williamsburg, Pacific Aviation Museum Pearl Harbor
Nonprofit foundation – history	Yad Vashem: The World Holocaust Remembrance Center
Nonprofit foundation – humanities	National Humanities Center
Nonprofit foundation – library	Jewish Virtual Library
Nonprofit foundation – museum	Museum of the Confederacy, Senator John Heinz History Center, Metropolitan Museum of Art, Seattle Art Museum, Winterthur, Carnegie Museum of Art, National Women's History Museum
Nonprofit foundation – museum/archive	Senator John Heinz History Center
Nonprofit foundation – museum/historic site	Monticello
Nonprofit foundation – presidential library	lbjlibrary.org (Lyndon Johnson)
Nonprofit foundation – science	New Mexico Ornithological Society
Nonprofit – education	TeachingHistory.org

TABLE 2A. WHAT KINDS OF IMAGES OR DOCUMENTS DID USERS UPLOAD?

Document or Image Source	Description or Example
Personal – blog	paulinespiratesandprivateers.blogspot.com
Personal – education	Personal photos/images
Personal – education from Smithsonian National Portrait Gallery source	Compare and Contrast National Portrait Gallery Images
Research facility	DNA Learning Center
Smithsonian	Smithsonian museums or Archives websites, Smithsonian Transcription Center, National Portrait Gallery, National Museum of American History, "Reading Portraiture" document, Hirshhorn social media
Smithsonian Magazine	Outwin exhibition article
Social media	Tumblr, Pinterest

TABLE 3A. UPLOADED WEBSITE SOURCE

Website Source	Description or Example
Academic – U.S. state university	University of Maryland, University of Virginia, University of California – Berkeley, University of Cincinnati
Commercial	rboutlaws.com
Commercial – art gallery blog	A dot-com site selling artwork burton morris.com
Commercial – artist's site	A dot-com site selling an artist's artwork timokamura.com
Commercial – city promotion	Promotional content for a city, Next Pittsburgh
Commercial – education	Ducksters.com, Gale group, National Geographic
Commercial – file storage	File sharing sites
Commercial – historic newspaper article (adapted)	*Old Post Gazette*
Commercial – history	ExplorePAHistory.com, History Channel, PopularPittsburgh.com
Commercial – journalism	BillMoyers.com, BBC, *NY Times*
Commercial – journalism – blog	Slate.com blog
Commercial – research site w/academic partners	Chronozoom.com
Commercial – search engine	Google (images)
Gov – U.S. fed agency – EPA	United States Environmental Protection Agency
Gov – U.S. fed agency – FBI	United States Federal Bureau of Investigation
Gov – U.S. fed agency – LOC	United States Library of Congress
Gov – U.S. fed agency – NARA	United States National Archives and Records Administration

TABLE 3A. UPLOADED WEBSITE SOURCE

Website Source	Description or Example
Gov – U.S. fed agency – NARA et al. (our docs)	United States NARA "Our Docs" site
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Gov – U.S. state – library/humanities	Connecticut Teach It
Gov – U.S. state agency – environment	New York State Department of Environmental Conservation
Nonprofit – encyclopedia	Wikipedia
Nonprofit – research consortium	Biodiversitylibrary.org
Nonprofit foundation – education	Poetry Foundation
Nonprofit foundation – educational media	PBS.org
Nonprofit foundation – history/archive	Gilder Lehrman Institute of American History
Nonprofit foundation – museum	
Nonprofit foundation – museum/archive	Newseum
Nonprofit foundation – museum/historic site	Monticello, Historic Jamestowne
Nonprofit – education	Teachinghistory.org
Personal – education	Classroom/teacher's blog
Smithsonian	Smithsonian Museums or Archives Websites
Smithsonian Learning Lab	Smithsonian Learning Lab site
Social media	Flickr

TABLE 4A. DOCUMENT OR IMAGE SOURCE(S) IN COLLECTIONS

Document or Image Source	Description or Example
Academic – historic atlas	Harper's Atlas of American History
Academic – international university archive	Institute of Historical Research – University of London
Academic – journal article	JSTOR, National Trust for Historic Preservation – Mesda
Academic – U.S. state university	University of Maryland University of Virginia University of California – Berkeley University of Cincinnati, University of Missouri – Kansas City, CUNY – NY, UMASS – Amherst
Commercial – art gallery	Gary R. Lucy Gallery
Commercial – artist's site	Kehinde Wiley
Commercial – blog	Slate, Glamour Daze
Commercial – e-book	Kindle
Commercial – e-commerce	Amazon, allposters.com
Commercial – education	National Geographic, viralnova.com
Commercial – encyclopedia	Encyclopedia Britannica
Commercial – file storage	File sites that point to images
Commercial – history	Gale Group, History Channel
Commercial – image site	Getty Images, Vintage Dancer
Commercial – journalism	CBS News, *TIME, Latin Magazine, New York Times, Cosmopolitan*
Commercial – journalism – blog	New York Times Magazine Blog
Commercial – journalism – historic	*Harper's Weekly, TIME* magazine covers
Commercial – science site	LiveScience
Commercial – search engine	Google (images)
Commercial – tourist	Google 360° Tourist Sites
Gov – international – environmental	Ecodatainforma (Brazil)
Gov – international archive	Berlin Government, Bibliothèque et Archives nationales du Québec
Gov – international museum	Louvre, Majdanek.eu, National Portrait Gallery (UK)
Gov – international state page	State in Brazil
Gov – U.S. city archive	City of Boston (MA)
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Gov – U.S. fed agency – NARA (DocsTeach)	United States National Archives' DocsTeach, docsteach.org
Gov – U.S. fed agency – NARA et al.	United States NARA, ourdocuments.gov
Gov – U.S. fed agency – NASA	United States National Aeronautics and Space Administration
Gov – U.S. fed agency – NOAA	United States National Oceanic and Atmospheric Administration
Gov – U.S. fed agency – NPS	United States National Park Service
Gov – U.S. fed agency – U.S. Senate	
Gov – U.S. fed agency – USGS	United States Geological Survey
Gov – U.S. fed museum – USHMM	United States Holocaust Memorial Museum
Gov – U.S. state – DCNR	State of Pennsylvania Department of Conservation and Natural Resources
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Gov – U.S. state – library/humanities	State Library of Massachusetts
Gov – U.S. state agency – environment	New York State Department of Environmental Conservation
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Nonprofit foundation – educational media	PBS.org
Nonprofit foundation – historic site	Fort Pitt Museum, Historic Jamestowne, Colonial Williamsburg, Pacific Aviation Museum Pearl Harbor
Nonprofit foundation – history	Yad Vashem: The World Holocaust Remembrance Center
Nonprofit foundation – humanities	National Humanities Center
Nonprofit foundation – library	Jewish Virtual Library
Nonprofit foundation – museum	Museum of the Confederacy, Senator John Heinz History Center, Metropolitan Museum of Art, Seattle Art Museum, Winterthur, Carnegie Museum of Art, National Women's History Museum
Nonprofit foundation – museum/archive	Senator John Heinz History Center
Nonprofit foundation – museum/historic site	Monticello
Nonprofit foundation – presidential library	lbjlibrary.org (Lyndon Johnson)

TABLE 4A. DOCUMENT OR IMAGE SOURCE(S) IN COLLECTIONS

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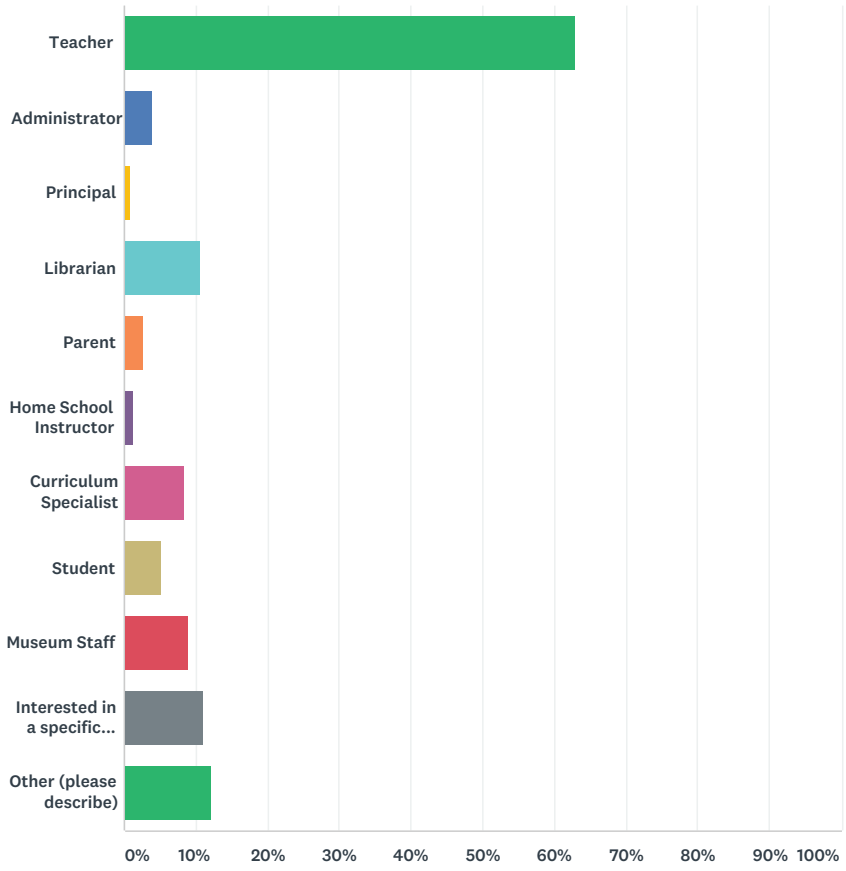
Nonprofit – education	Teaching History.org
Personal – blog	paulinespiratesandprivateers.blogspot.com
Personal – education	Personal photos/images
Personal – education from Smithsonian National Portrait Gallery source	Compare and contrast National Portrait Gallery images
Research facility	DNA Learning Center
Smithsonian	Smithsonian museums or archives' websites, Transcription Center, National Portrait Gallery, Smithsonian American Archives, National Museum of American History, "Reading Portraiture" document, Hirshhorn social media
Smithsonian Magazine	Outwin exhibition article
Social media	Tumblr, Pinterest

Appendix B
Lab User Survey: All Data

Q1 Did you use the Smithsonian Learning Lab as a (please select all that apply):

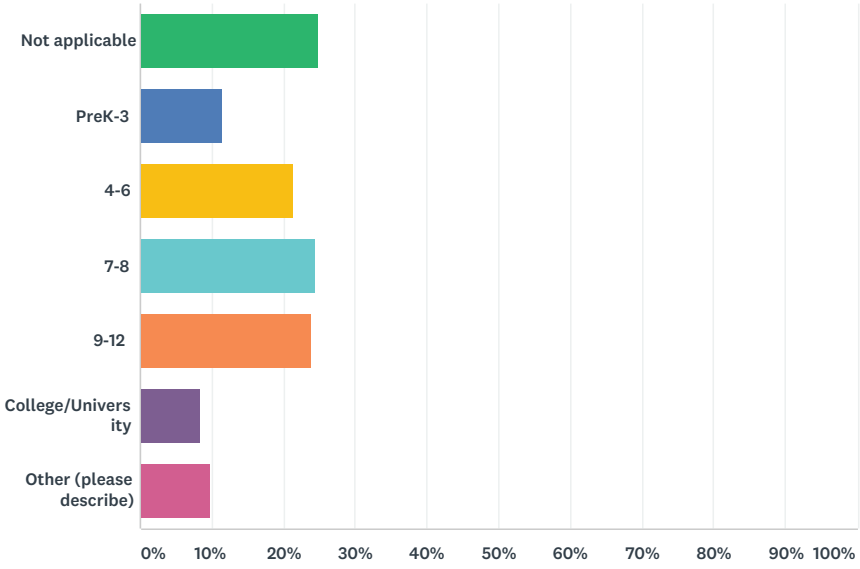
Answered: 407 Skipped: 0



ANSWER CHOICES	RESPONSES	
Teacher	62.90%	256
Administrator	3.93%	16
Principal	0.74%	3
Librarian	10.57%	43
Parent	2.70%	11
Home School Instructor	1.23%	5
Curriculum Specialist	8.35%	34
Student	5.16%	21
Museum Staff	9.09%	37
Interested in a specific topic/subject	11.06%	45
Other (please describe)	12.04%	49
Total Respondents: 407		

Q2 If you are a teacher, what grade do you teach? (please select all that apply)

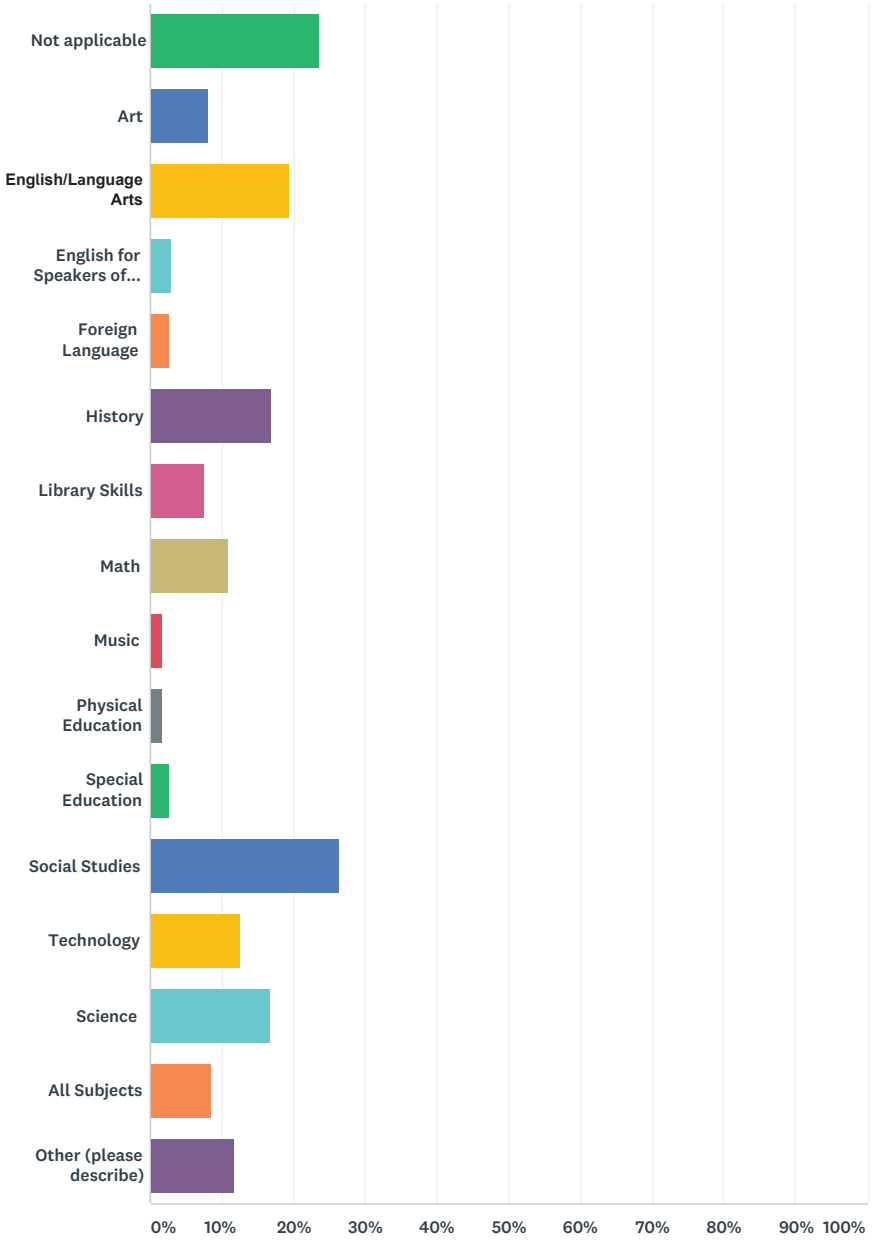
Answered: 407 Skipped: 0



ANSWER CHOICES	RESPONSES	
Not applicable	24.82%	101
PreK-3	11.55%	47
4-6	21.38%	87
7-8	24.57%	100
9-12	23.83%	97
College/University	8.35%	34
Other (please describe)	9.83%	40
Total Respondents: 407		

Q3 If you are a teacher, what subjects do you teach? (please select all that apply)

Answered: 407 Skipped: 0

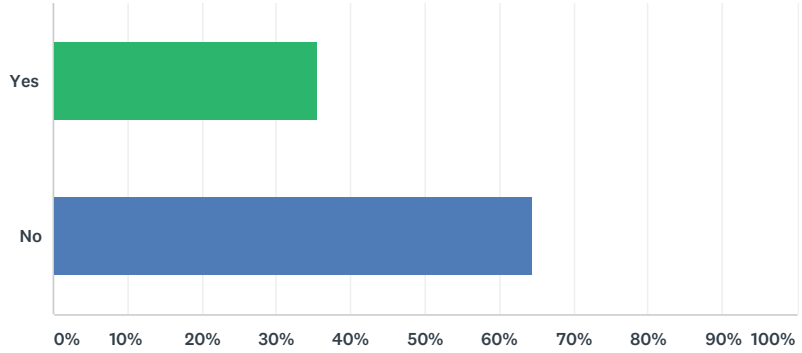


Smithsonian Learning Lab User Survey 2017

ANSWER CHOICES	RESPONSES	
Not applicable	23.59%	96
Art	8.11%	33
English/Language Arts	19.41%	79
English for Speakers of Other Languages	2.95%	12
Foreign Language	2.70%	11
History	16.95%	69
Library Skills	7.62%	31
Math	10.81%	44
Music	1.72%	7
Physical Education	1.72%	7
Special Education	2.70%	11
Social Studies	26.29%	107
Technology	12.53%	51
Science	16.71%	68
All Subjects	8.60%	35
Other (please describe)	11.79%	48
Total Respondents: 407		

Q4 Did you receive training about the Smithsonian Learning Lab?

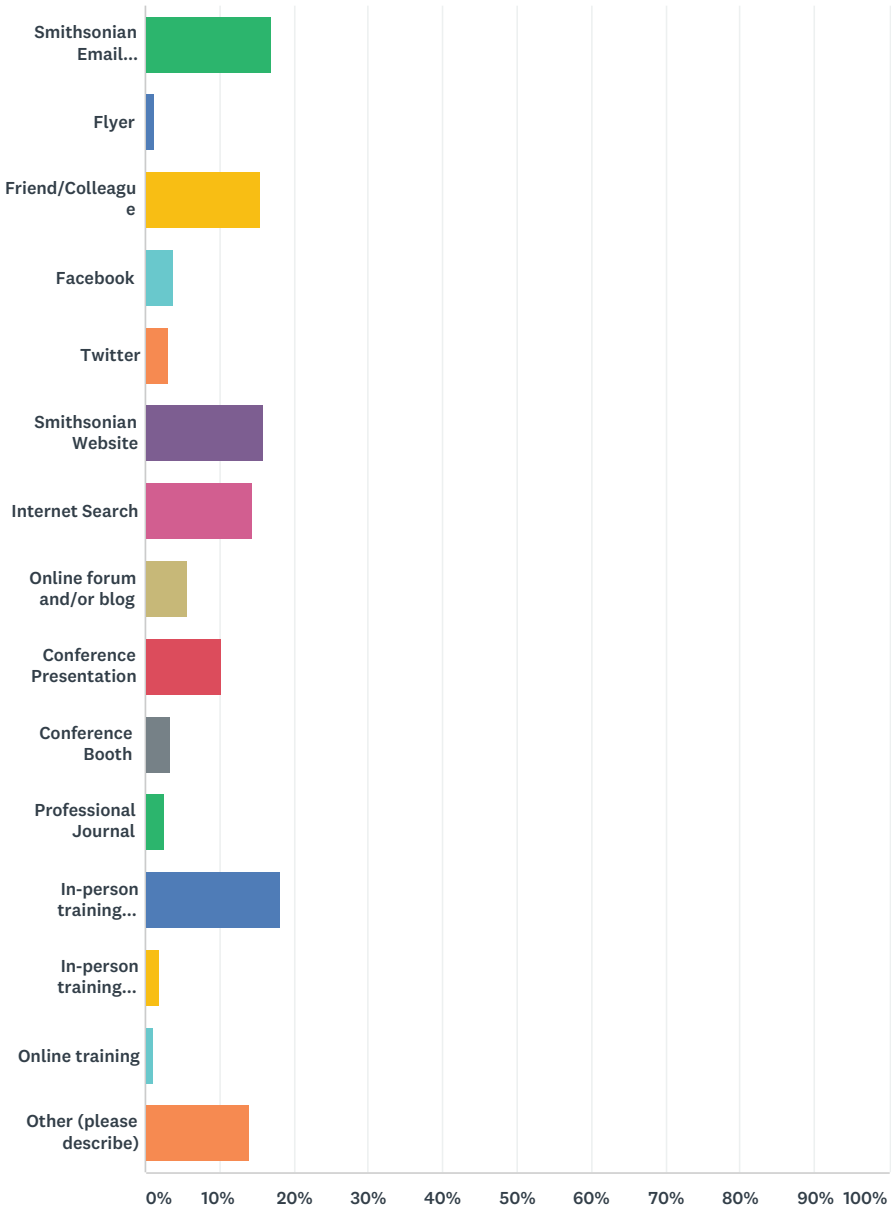
Answered: 407 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	35.63%	145
No	64.37%	262
TOTAL		407

Q5 How did you hear about the Smithsonian Learning Lab? (please select all that apply)

Answered: 407 Skipped: 0



Smithsonian Learning Lab User Survey 2017

ANSWER CHOICES	RESPONSES	
Smithsonian Email Newsletter	16.95%	69
Flyer	1.23%	5
Friend/Colleague	15.48%	63
Facebook	3.69%	15
Twitter	3.19%	13
Smithsonian Website	15.97%	65
Internet Search	14.50%	59
Online forum and/or blog	5.65%	23
Conference Presentation	10.32%	42
Conference Booth	3.44%	14
Professional Journal	2.46%	10
In-person training session by a Smithsonian staff	18.18%	74
In-person training session by a non-Smithsonian staff	1.97%	8
Online training	0.98%	4
Other (please describe)	14.00%	57
Total Respondents: 407		

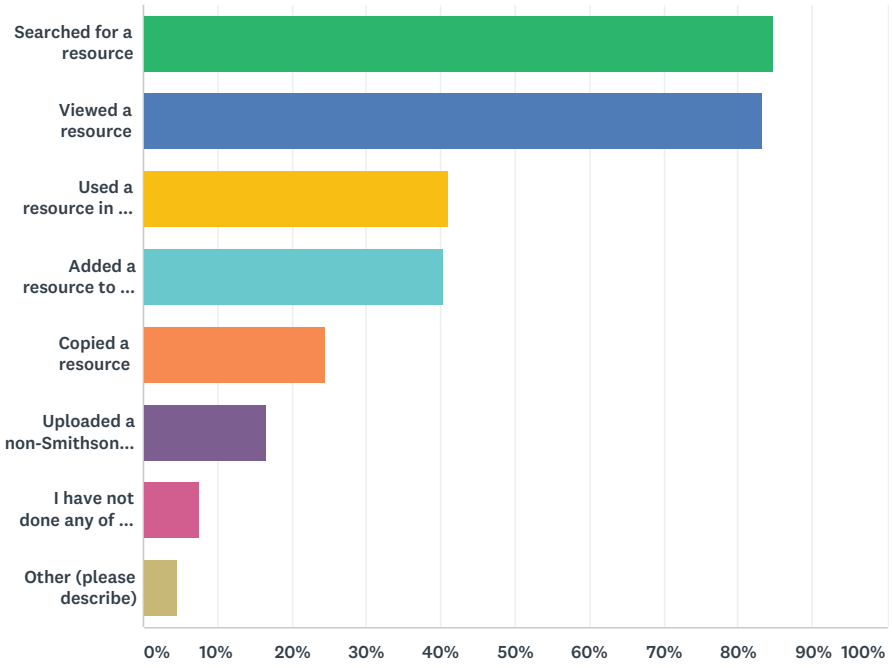
Q6 What is your home zip code or postal code?

Answered: 407 Skipped: 0

Data intentionally omitted.

Q7 Did you do any or all of the following with a Smithsonian Learning Lab resource? A resource includes an image, video, text or learning resource included within the Smithsonian Learning Lab. (please select all that apply)

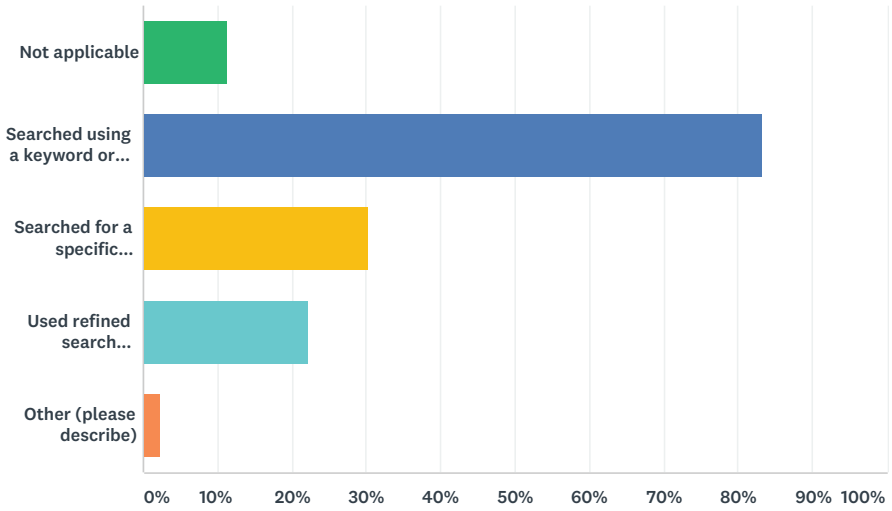
Answered: 387 Skipped: 20



ANSWER CHOICES	RESPONSES	
Searched for a resource	84.75%	328
Viewed a resource	83.20%	322
Used a resource in a classroom to teach	41.09%	159
Added a resource to a collection	40.31%	156
Copied a resource	24.55%	95
Uploaded a non-Smithsonian resource	16.54%	64
I have not done any of the above	7.49%	29
Other (please describe)	4.65%	18
Total Respondents: 387		

Q8 If you used the search function, how did you search for the Smithsonian Learning Lab resources? (please select all that apply)

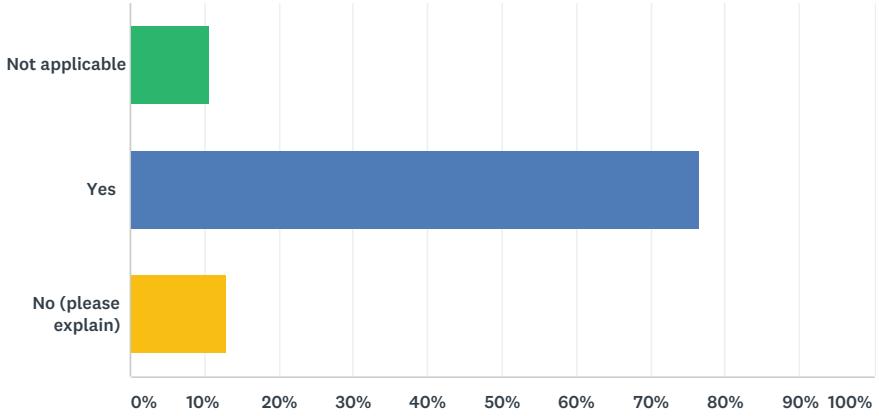
Answered: 387 Skipped: 20



ANSWER CHOICES	RESPONSES	
Not applicable	11.37%	44
Searched using a keyword or topic and browsing the results (Example: Civil War)	83.20%	322
Searched for a specific resource (Example: a portrait of an American President)	30.23%	117
Used refined search (Example: By image)	22.22%	86
Other (please describe)	2.33%	9
Total Respondents: 387		

Q9 If you searched for a resource, did you find what you were looking for?

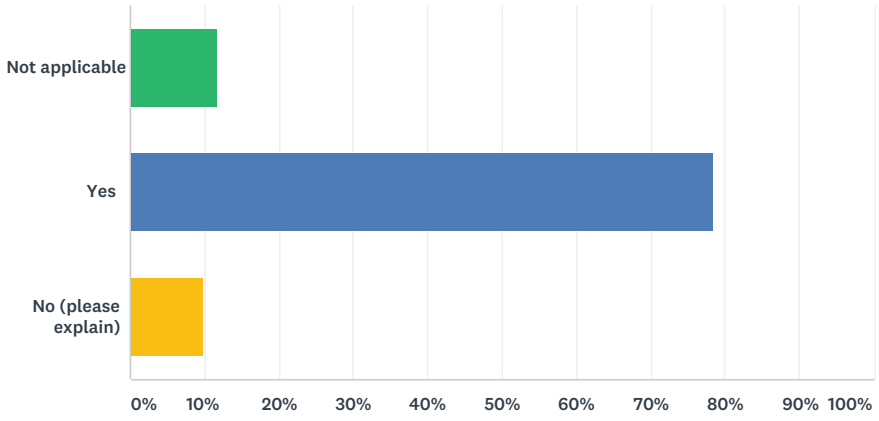
Answered: 387 Skipped: 20



ANSWER CHOICES	RESPONSES	
Not applicable	10.59%	41
Yes	76.49%	296
No (please explain)	12.92%	50
TOTAL		387

Q10 If you viewed a resource, did it have the description and information you were looking for?

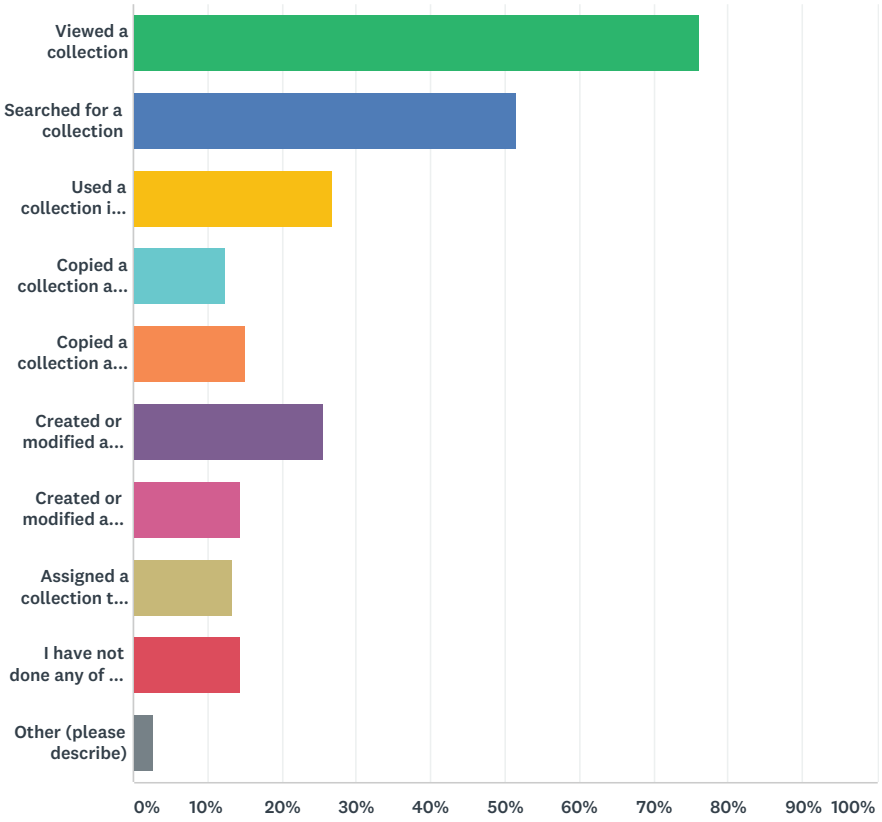
Answered: 387 Skipped: 20



ANSWER CHOICES	RESPONSES	
Not applicable	11.63%	45
Yes	78.55%	304
No (please explain)	9.82%	38
TOTAL		387

Q11 Did you do any or all of the following with Smithsonian Learning Lab collections? Collections are purposefully organized groupings of resources. (please select all that apply)

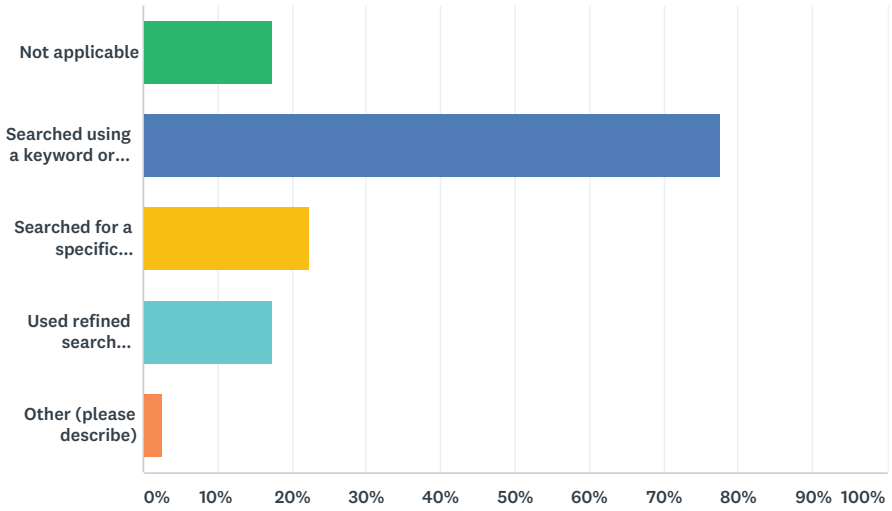
Answered: 365 Skipped: 42



ANSWER CHOICES	RESPONSES	
Viewed a collection	76.16%	278
Searched for a collection	51.51%	188
Used a collection in a classroom to teach	26.85%	98
Copied a collection and used as is	12.33%	45
Copied a collection and modified it	15.07%	55
Created or modified a collection and did not publish it	25.48%	93
Created or modified a collection and published it	14.52%	53
Assigned a collection to students	13.42%	49
I have not done any of the above	14.52%	53
Other (please describe)	2.74%	10
Total Respondents: 365		

Q12 How did you search for the Smithsonian Learning Lab collections? (please select all that apply)

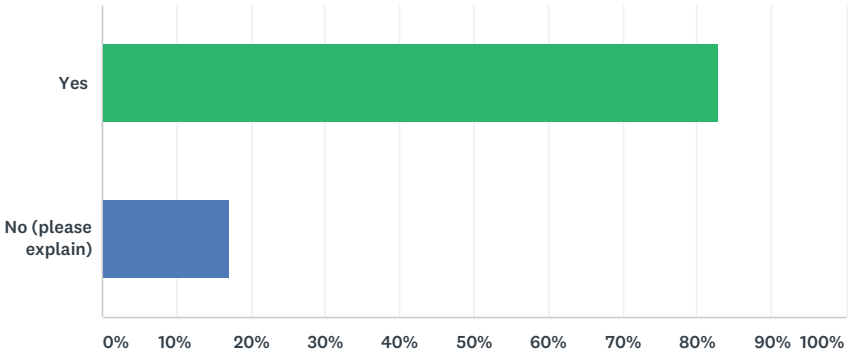
Answered: 365 Skipped: 42



ANSWER CHOICES	RESPONSES	
Not applicable	17.26%	63
Searched using a keyword or topic (Example: Civil War)	77.53%	283
Searched for a specific collection (Example: How Things Fly)	22.47%	82
Used refined search (Example: By subject)	17.26%	63
Other (please describe)	2.47%	9
Total Respondents: 365		

Q13 If you searched for a collection, did you find what you were looking for?

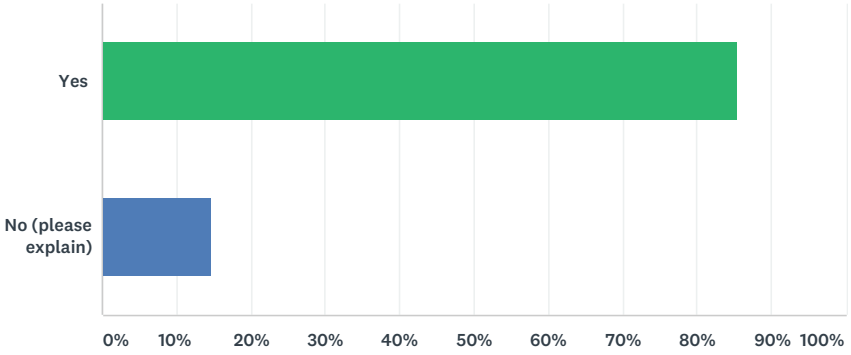
Answered: 316 Skipped: 91



ANSWER CHOICES	RESPONSES	
Yes	82.91%	262
No (please explain)	17.09%	54
TOTAL		316

Q14 When you viewed a collection, did it have the description and information you were looking for?

Answered: 327 Skipped: 80



ANSWER CHOICES	RESPONSES	
Yes	85.32%	279
No (please explain)	14.68%	48
TOTAL		327

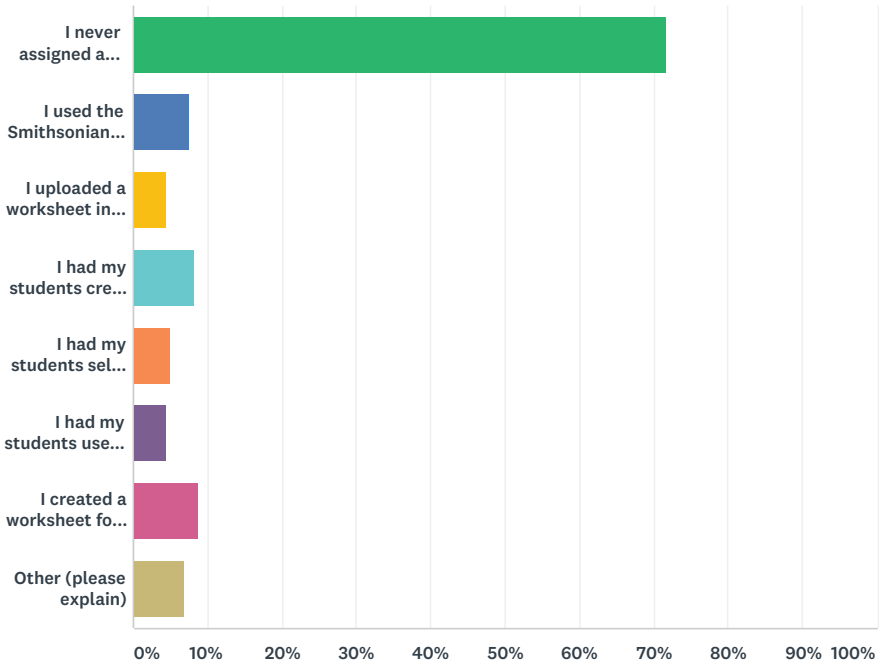
Q15 If you copied a collection and modified it, how did you modify the collection you copied? Please describe.

Answered: 101 Skipped: 306

Data intentionally omitted.

Q16 If you assigned a collection to students, what action did you take (please select all that apply)

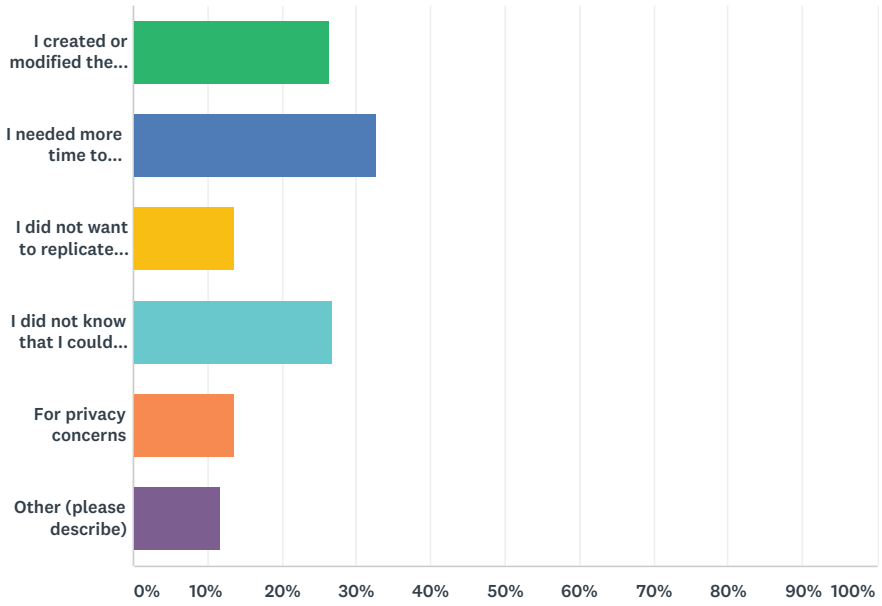
Answered: 293 Skipped: 114



ANSWER CHOICES	RESPONSES	
I never assigned a collection to my students	71.67%	210
I used the Smithsonian Learning Lab assignment tool	7.51%	22
I uploaded a worksheet in the collection as an assignment (please explain)	4.44%	13
I had my students create or modify collections	8.19%	24
I had my students select resources that I then assembled in a collection	5.12%	15
I had my students use Smithsonian Learning Lab resources for an assignment outside of the platform (for example, by creating a video with Smithsonian Learning Lab resources, or uploading resources on a different platform) (please explain)	4.44%	13
I created a worksheet for my students that I did not upload in the collection	8.87%	26
Other (please explain)	6.83%	20
Total Respondents: 293		

Q17 If you did not publish a collection, why did you decide to keep the collection unpublished? (please select all that apply)

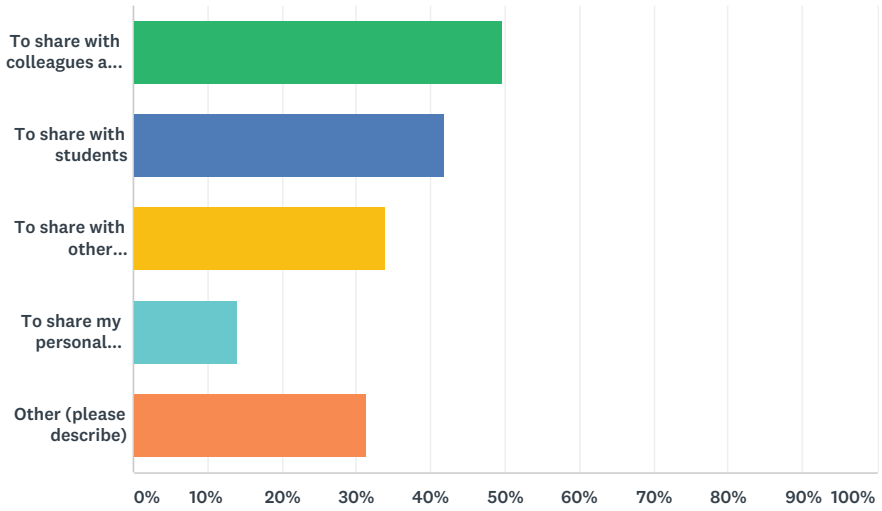
Answered: 266 Skipped: 141



ANSWER CHOICES	RESPONSES	
I created or modified the collection without intending to publish it	26.32%	70
I needed more time to finalize the collection	32.71%	87
I did not want to replicate an existing published collection	13.53%	36
I did not know that I could publish the collection	26.69%	71
For privacy concerns	13.53%	36
Other (please describe)	11.65%	31
Total Respondents: 266		

Q18 If you did publish a collection, why did you choose to publish the collection you created? (please select all that apply)

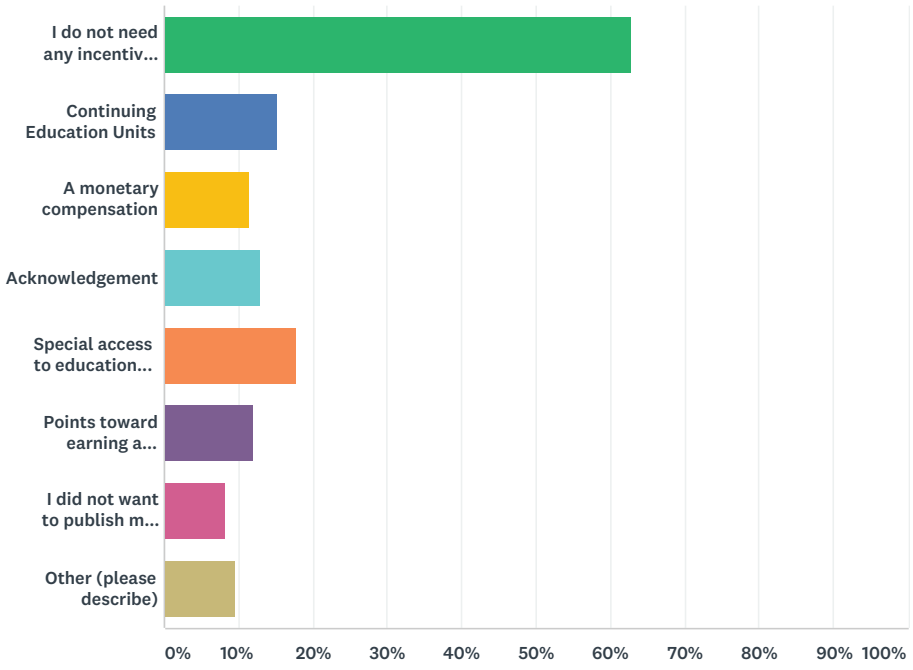
Answered: 115 Skipped: 292



ANSWER CHOICES	RESPONSES	
To share with colleagues and peers	49.57%	57
To share with students	41.74%	48
To share with other Smithsonian Learning Lab users	33.91%	39
To share my personal passions, expertise, and interests	13.91%	16
Other (please describe)	31.30%	36
Total Respondents: 115		

Q19 What incentive(s) might lead you to publish your collection? Please select all that apply

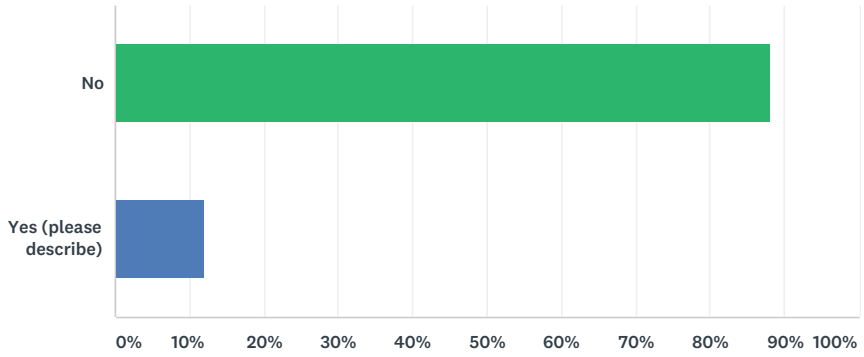
Answered: 355 Skipped: 52



ANSWER CHOICES	RESPONSES	
I do not need any incentives to publish collections	62.82%	223
Continuing Education Units	15.21%	54
A monetary compensation	11.55%	41
Acknowledgement	12.96%	46
Special access to educational features	17.75%	63
Points toward earning a reward	11.83%	42
I did not want to publish my collection under any circumstances	8.17%	29
Other (please describe)	9.58%	34
Total Respondents: 355		

Q20 Other than to discover resources and/or create collections, have you used the Smithsonian Learning Lab in any other way?

Answered: 337 Skipped: 70



ANSWER CHOICES	RESPONSES	
No	88.13%	297
Yes (please describe)	11.87%	40
TOTAL		337

Q21 Would you recommend the Smithsonian Learning Lab to a friend or a colleague?

Answered: 348 Skipped: 59

ANSWER CHOICES	RESPONSES	
Yes (please describe)	93.10%	324
No (please describe)	8.05%	28

Appendix C
Lab Changes: A Summary

Overview/justification for iterative software development

The Smithsonian Learning Lab was developed using a "minimum viable product" model, in that features were only developed to the point that they were functional, and never beyond. The intent behind publishing "unfinished" features was to ensure that they matched as closely as possible with user needs. The feature specifications were originally based on the previous user research, but the development team recognized that, despite best efforts, including extensive literature and environmental reviews, and extensive user testing with a wide variety of target end users, the needs to continually evolve the features of the platform would not wane. Therefore, as we designed and developed the tools of the Lab, we staggered their development so that we could learn from actual users how they would need to adapt to be "complete." The persistence of the "feedback" button on all pages of the Lab beyond the beta period ensured that a visible and simple method for capturing user feedback was present. Feedback captured from this form, as well as through dozens of workshops, presentations, and so forth were used to prioritize feature evolution and new feature development.

We continue to rely on this process to enhance the Lab.

Examples of changes aligned to each of the grant goals

Bi-weekly release notes are available from December 1, 2015, to the present that detail more than 1,200 individual changes made to the Lab, including many user interface and user experience changes that do not fall directly into the goals of this grant detailed below (for example, the addition of support for 3D graphics in the Lab).

The following are changes made to the Lab that directly align with the goals of the grant.

1. Identify strategies to make it easier to find teacher-created digital collections.
    - Added introductory animations (that explain at a high level what is possible under Discover, Create, and Share), accessible from the homepage
    - Added homepage videos that explain what the Lab is and why I should use the Lab
    - Added additional filters to support enhanced search results filtering
    - Improved the pagination navigation for search results

- Added a link to the resource page information that links to the collections that contain that resource
- Created standard icons for resources without a thumbnail
- Added auto-generated screenshots for web-based resources that did not have a thumbnail
- Added visual identification of Smithsonian staff in search results/filter by Smithsonian-created collections
- Added the embed tool allowing anyone to embed individual resources or entire collections on other, non-Smithsonian websites

2. Analyze the characteristics of teacher-created digital sets and how teachers use specific tools
   - Created an administrative dashboard for collections, so that the Smithsonian Center for Learning and Digital Access could quickly search and understand user-created collections
   - Developed enhanced Google Analytics integrations so that the Center could better understand users and user behavior
   - Created the Sorting Tool(s)
   - Addition of rich text to user-created descriptions (to enable hyperlinked, text formatting, etc.)
   - Created the Zoom-lock Tool that allows users to set the open position and zoom state for resources
   - Added the ability for users to create freestanding Annotations/Assessment
   - Added the ability for users to reorder resources within collections

3. Determine the types of supports needed by teachers having different access to and expertise with technology, skills in curriculum development, and experience using museum resources.
   - Added additional text to the homepage describing how to get started
   - Added introductory animations (that explain at a high level what is possible under Discover, Create, and Share), accessible from the homepage
   - Added homepage videos that explain what the Lab is and why I should use the Lab
   - Added suggest strategies on the homepage, linking to Harvard Visible Thinking routines
   - Enhanced collection editing features
   - Added the ability to search the Lab and add multiple search results simultaneously, while within Edit mode

- Created a visual indication (green bar) of an active edit state
- Added a Popup for Resource/Collection page for new users when they enter the Lab directly from outside the Lab
- Buttons for Edit/Publish enlarged and colored
- Added User dashboard enhancements/visibility

4. Document students experience using teacher-created digital sets
   - Addition of Rosters/Assignments
   - Added Share to Google Classroom for all resources and collections
   - Added FERPA/COPPA Compliance, with third-party review and approval
   - Enhanced mobile/tablet experience (multiple user interface changes to improve the user experience)
5. Analyze the use of the tagging tool
   - Simplified fields and field options in collection metadata tagger
   - Created an improved metadata tagger prompt (to encourage the addition of collection metadata) when a user publishes a collection

Summer 2017

With permission from the Carnegie Corporation, some grant budget was realigned to support Lab changes to better support data collection and other grant goals. These changes include enhancements to the administrative dashboard to support the Center administrators in understanding users and collections created on the Lab. Features include:

- Enhanced mechanisms for dealing with flagged content
- Improvements to collection metadata reporting
- Improvements to resource metadata reporting
- Improvements to administrative (high-level) dashboard display/reporting

Two additional features that support both the proper citation of Lab content and the creation of new metadata are being added. The first will create an "Easy Citation" button on all pages encouraging those using information and images from the Smithsonian and other places to properly cite their source. The second will encourage users to include more complete information on the source of uploaded resources and prompt them to provide additional collection-level metadata when they publish collections for other users to discover and use.

Appendix D
Lab Resources with Varying Metadata

An Air Balloon, National Air and Space Museum

Identified for: lengthy description, too much context, museum-centric
https://learninglab.si.edu/resources/view/13878/search#more-info

Jenny Lind, National Portrait Gallery

Identified for: simple one-paragraph description explaining the significance of why the museum includes this object, bilingual description
https://learninglab.si.edu/resources/view/955137/search#more-info

Hemiptera, National Museum of Natural History

Identified for: no description, includes scientific taxonomy, no common name information, NMNH website has a little more information that would be useful
https://learninglab.si.edu/resources/view/476446/search
https://collections.nmnh.si.edu/search/ento/?irn=9313120

Letter Describing the 1913 Suffrage Parade, National Museum of American History

Identified for: strong two-paragraph description; *Note:* "A transcription of the letter follows:" with no transcription
https://learninglab.si.edu/resources/view/51724/search#more-info

Certified Proof, National Museum of American History

Identified for: no keywords related to how someone would search, limited description available in the "Name" section
https://learninglab.si.edu/resources/view/1285328/search#more-info

Batman 2, Smithsonian American Art Museum

Identified for: without the context of the resource description, the user might be uncertain of why it would be included in a museum; two paragraphs highlight the artist's intent
https://learninglab.si.edu/resources/view/296022/search#more-info

Andrew Carnegie, National Portrait Gallery

Identified for: keywords structure, no description
https://learninglab.si.edu/collections/pittsburgh-from-the-age-of-industrialization-to-the-age-of-information/auFA9XtUmHyaiAG5#r/88283

Outfit worn by Carlotta Walls to Little Rock Central High School, National Museum of African American History and Culture

Identified for: sentence-long caption describing object and context; however, this caption is located in a section called "Notes" instead of "Description" and difficult to locate.
https://learninglab.si.edu/q/r/771500

Head of the Buddha, Freer Sackler Galleries

Identified for: no description on Lab; however, a detailed 2-paragraph description (written in high-level language) is found on the asia.si.edu website that explains object and context. This is typical of many items from the Freer Sackler Galleries— if resources contain a description, it is not visible on the Lab.
https://learninglab.si.edu/q/r/246015

Hansen Writing Ball (Commercial), Cooper-Hewitt

Identified for: no description on Learning Lab; however, a paragraph-long description, explaining the context and significance of the resource in accessible language, is found on the CH website. This is typical of many items from CH— if resources contain a description, it is not visible on the Lab.
https://learninglab.si.edu/q/r/346210

Vigilant Fire Hat, National Museum of American History

Identified for: two-part description—first part includes a paragraph describing "Fire Hats," including how they were used and their context. This paragraph is found on all fire hat resources. The second paragraph explains the specific significance of the resource it is individually attached to, explaining symbolism and community.
https://learninglab.si.edu/q/r/150007

Two women looking through doughnuts, National Museum of American History

Identified for: description based on the collection of "tintypes," but also the specific tintype you are looking at and its significance
https://learninglab.si.edu/resources/view/27252/search#more-info

La comédie de notre temps. La civilité ; les habitudes; les moeurs; les coutumes; les manières; et les manies de notre époque, Smithsonian Libraries

Identified for: lack of thorough explanatory description of how or why to access, no English translation
https://learninglab.si.edu/resources/view/631124/search#more-info

Graveyard on Bikini Island, National Museum of American History

Identified for: information regarding the specific photograph, and the *LIFE* magazine article it was taken from; *LIFE* magazine article information is edited slightly and included in each photograph from the magazine article included in NMAH's collection
https://learninglab.si.edu/q/r/131610

"Wings Over America" Poster, National Museum of American History

Identified for: provides a general description for World War II posters as whole
https://learninglab.si.edu/resources/view/9130/search#more-info

Vantage Point—"Take a Picture with a Real Indian" (James Luna performance), National Museum of the American Indian

Identified for: video of performance art piece, description includes information regarding artistic intent for the performance and context of where and when this piece was performed.
https://learninglab.si.edu/q/r/101334

Appendix E
Online Museum Resource Metadata: Implications for Museum and Teacher Educators

Online Museum Resource Metadata: Implications for Museum and Teacher Educators

D. Zinger, R. Hatanaka, and S. Quach

Accepted for the 2018 meeting of the American Educational Research Association

1. Objectives

Information technology continues to evolve rapidly, and recently museum professionals have increasingly used technology to expand museums' reach to the web (Jones, 2007). This expansion has the potential to democratize access to museums through the Internet (Parry, 2007). Online databases are one museum-developed tool for uploading their digitized artifacts and objects to the web (Matusiak, 2006; Skov & Ingwersen, 2014). These artifacts and objects, or resources, have museum-generated information attached, or metadata, designed to provide descriptive information (Baca, Coburn, & Hubbard, 2007). One targeted user group of these museum uploaded resources is educators, who might use metadata to both find instructional resources, and use them in their own instruction (Abbott & Cohen, 2015). However, as Marty (2008) suggests, the metadata provided by museum staff may not be helpful to users for searching or use of resources. This potential disconnect between the purpose and utility of digital museum metadata and what teachers find useful poses challenges to both museum and teacher educators who are charged with supporting teacher learning and use of digital museum resources.

The purpose of this study is to help museum and teacher educators better understand the available museum metadata and what metadata teachers find most useful so that they can better design learning and supports for teachers. To that end, we focus on one online museum platform, the Smithsonian Learning Lab (SLL) and examine the types of metadata available online with its uploaded resources. We also examine the types of metadata present in resources used by teachers from the SLL. Our study is guided by three research questions:

1. What are the different categories of teacher-related metadata in digitized museum resources? How frequently do these categories of metadata appear in resources?
2. What categories of metadata are found in teacher-used resources? How frequently do these categories of metadata appear in resources?
3. What is the relationship between the frequency of resource metadata categories generated by museums and used by teachers?

2. Theoretical Framework

Supporting teacher learning with technology is an ongoing and challenging endeavor (Authors, 2011). Though professional development (PD) continues to be central to teacher learning, it is often found to be ineffective (Guskey, 2014) To promote teacher learning, approaches need to move beyond the "technocentrist" and attend to teacher needs (Papert, 1990; Authors, 2017a). Positive teacher learning outcomes have been achieved in technology-based PD when teacher contexts and needs are taken into account (Authors, 2017b).

Traditionally, museums have used exhibits to present their resources and less attention has been paid to how users might search for resources (Skov, 2009). With the emergence of digital museum resources, metadata has become critical to user searching and engagement with resources (Skov & Ingwersen, 2014). In the case of teaching and supporting teachers in the use of digital museum resources, identifying what information teachers use for searching and teaching becomes central. Better understanding this can help teacher educators better support teacher searching for resources as well as how to they use metadata instructionally.

3. Method

This is a mixed methods study employing both qualitative and quantitative approaches. A qualitative approach was used to generate metadata categories based on the information available from resources. Frequency counts were then used to determine how often each coded category was present in resources. Finally, a two-tailed t-test was used to determine if the metadata category frequencies were different between typical museum resources and resources used by teachers.

Study context: The Smithsonian Learning Lab, and resources used by a cohort of middle school teachers. The SLL is an online museum platform designed to provide educators with tools and resources to explore and design collections of resources (from the 19 Smithsonian museums). These teacher created collection can then be used with various tools such as built in quizzes and sorting activites to promote student learning. The digital museum resources used in our study were entirely drawn from the SLL. To identify teacher-used resources, we used resources in instructional collections created by a cohort of 33 teachers who had received training in the use of the SLL.

4. Data Sources & Analysis

Data sources. We initially randomly selected 200 resources from the SLL to be analyzed as representative of museum resources. We then selected 139 resources to be analyzed from 18 teacher-generated SLL teaching collections, as resources used by teachers for instruction. We selected this particular group of teacher resources because the SLL is an open platform, and we could verify that these resources were indeed used by teachers for instruction.

Data Analysis.

RQ1: What are the different categories of teacher-related metadata in digitized museum resources? How frequently do these categories of metadata appear in resources?

To identify the teacher-relevant descriptive characteristics of metadata, we iteratively created a codebook. We initially analyzed 50 randomly selected resources, a number that provided a saturation point, and divided metadata contents into descriptive categories. We then themed these categories and identified 11 categories that were likely to be useful to teachers. Based on the codebook, two of the authors independently coded 120 out of 200 randomly selected resources, and the initial interrater reliability was 98%. Subsequently, the remaining 80 resources were coded by the authors independently. Frequency counts were then used to determine how often each of the 11 identified metadata categories were present in the resources.

RQ2: What categories of metadata are found in teacher-used resources? How frequently do these categories of metadata appear in resources?

To determine the types and frequency of teacher-used resource metadata, we used a similar approach as in RQ1. The 139 teacher-used resources were split between two of the authors and coded individually. Frequency counts were then used to determine how often each metadata category was present in the teacher-used resources.

RQ3: What is the relationship between the frequency of resource metadata categories generated by museums and used by teachers?

We compared the frequency rates of specific metadata categories in the randomly selected and teacher-used resources. To determine statistical significance, we performed a two-tailed t-test between each of the eleven metadata categories.

5. Findings

We found 11 categories of digital museum resource metadata which might be helpful for teachers to use. Randomly selected resources showed five categories that frequently appeared in the metadata (over 70%), while six categories appeared at much lower frequencies (less than 10%). In the resources teachers used, metadata category frequencies were over 40% for all but one of the categories. We found that the metadata categories found in low-frequency in the random resources were present at significantly higher rates in the teacher-used resources. This suggests that the types of information that museum professionals put on the resources less frequently are important for teachers to use the resources in the classroom settings.

RQ1: What are the different categories of teacher-related metadata in digitized museum resources? How frequently do these categories of metadata appear in resources?

We found a total of 11 categories of metadata relevant to teachers through our examination of SLL digital resources (see Table 1E). Of these categories, six provided very short descriptors of the resource. These included the name, and origin or source of the resource, the date the object was created and date of the event it might depict, the name of the creator and subject of the resource. Of these categories, five appeared at a high rate of randomly selected resources, with date of the event (5%) being the only category appears in less than 70% of resources (see Figure 1). The remaining categories provided more in depth and contextualized information and included either a basic or more detailed description of the resource, the historical context of the resource, the cultural context of the resource, and the impact or an analysis of the resource. These categories appeared in the randomly selected resources at a rate of between 4–10%. This difference established two clear groups of metadata categories, those present with high frequency and those with low frequency.

RQ2: What categories of metadata are found in teacher-used resources? How frequently do these categories of metadata appear in resources?

Teacher-used resources revealed a different pattern of metadata categories. In teacher-used resources, all but two of the 11 categories were present at a higher frequency than 40% (see Figure 2E). The two categories present in less than 40% of resources were a basic description (24%) and date of event (19%). Of note is that detailed description (present in 44% of teacher-used resources) could not co-occur with basic description. We analyzed the differences in metadata frequency between the randomly selected and teacher-used resources in RQ3.

RQ3: What is the relationship between the frequency of resource metadata categories generated by museums and used by teachers?

In comparing frequencies of the metadata categories in random and teacher-used resources, we found that in all but three categories (name of the creator and object, and the origin of the resource) were present more frequently in teacher-used resources than randomly selected museum resources (see Figure 3E). We also found that the differences in frequency in 10 of the 11 metadata categories to be statistically significant (see Table 2E). Our analysis showed that teacher-used resources had significantly higher rates of the low-frequency (sub 10%) metadata categories found in random resources. Indeed, the four categories of metadata with the largest effect sizes also represented low-frequency categories which were sub 10% in random resources, but were present at rates higher than 40% for teacher-used resources. These categories were a detailed description, historical and cultural contexts, and analysis or the impact of the resource.

The results suggest that educators were statistically significantly more likely to use resources that contained these four categories as well as the other two low-frequency random resource categories than found in random resources. The four categories also represent data that provides contexts and can help teachers make sense of resources, whereas the high-frequency categories only provide very basic data.

6. Scholarly Significance

Our findings point to teachers seeking and using museum digital resources that include rich descriptions and provide context for the resource. These rich metadata categories are infrequently available in museum resources, suggesting that teachers may need to spend significant time looking for resources that meet their criteria. Consequently, as museums continue to move to increase access to their physical resources by digitizing them, both museums and teacher educators, and museum staff should be mindful of the implications of the type of metadata that is, or is not attached to uploaded digital resources. Museum staff should be aware that some metadata, especially rich descriptive metadata that may be less valuable or important internally to museums may be very important to teachers. Museum educators can work with museum staff to better understand and identify the type of information that teachers are likely to find useful and ensure that resources that are uploaded include that information.

Additionally, both museum and teacher educators should be aware of the type of metadata that is more likely to be useful for teachers. This can first guide the type of PD or learning provided for teachers about searching for resources and streamline the process to finding resources that have richer metadata which teachers are looking for.

Secondly, teacher educators can use resources with richer, detailed, metadata for PD and other teacher instructional programs so that teachers experience learning with resources that they are more likely to use. Using resources that have rich metadata may encourage teachers to use museum platforms such as the SLL as they can get the digital resource as well as rich data about it, as opposed to using more open internet searches that may yield a resource, but not the supporting data.

References

Authors (2011)

Authors (2017a)

Authors (2017b)

Abbott, F., & Cohen, D. (2015). Using Large Digital Collections in Education: Meeting the Needs of Teachers and Students, *Digital History: The Future of Exploring the Past.*

Baca, M., Coburn, E., & Hubbard, S. (2007). Metadata and Museum Information. In P. F. Marty & K. B. Jones (Eds.), *Museum Informatics: People, Information, and Technology in Museums* (pp. 107–127). New York, NY: Routledge.

Guskey, T. R. (2014). Planning Professional Learning. *Professional Learning: Reimagined*, 71(8), 10–16. http://doi.org/10.1017/CBO9781107415324.004

Jones, K. B. (2007). The transformation of the digital museum. In P. F. Marty & K. B. Jones (Eds.), *Museum Informatics: People, Information, and Technology in Museums* (pp. 9-25). New York, NY: Routledge.

Matusiak, K. K. (2006). Towards user-centered indexing in digital image collections. *International Digital Library Perspectives,* 22(4), 283–298. doi: 10.1108/10650750610706998

Marty, P. F. (2008) Museum websites and museum visitors: digital museum resources and their use, *Museum Management and Curatorship, 23(1),* 81-99, doi: 10.1080/09647770701865410

Papert, S. (1990). A critique of technocentrism in thinking about the school of the future. *Epistemology and Learning MIT Media Laboratory.* Retrieved from http://www.papert.org/articles/ACritiqueofTechnocentrism.html

Parry, R. (2007). *Recording the museum digital heritage and the technologies of change.* New York, NY: Routledge.

Skov, M. (2009). The reinvented museum: Exploring information seeking behaviour in a digital museum context (Unpublished doctoral dissertation). Copenhagen, Denmark: Royal School of Library and Information Science. Retrieved from http://pure.iva.dk/files/30768221/MetteSkovThesis.pdf

Skov, M., & Ingwersen, P. (2014) Museum web search behavior of special interest visitors, *Library & Information Science Research, 36,* 91-98, doi: 10.1016/j.lisr.2013.11.004

TABLE 1E. METADATA RESOURCE CODES AND DESCRIPTIONS

Code	Description
Basic Description	Describes the historical or cultural event of the resource in one or two sentences
Detailed Description	Describes the historical or cultural event of the resource in three or more sentences (or paragraphs)
Impact and Analysis	Provides perspective on why subject matter is important to study, and gives a brief analysis of the subject
Historical Context	Describes the history behind/within the resource and its general place in history
Cultural Context	Provides related cultural aspect/proverb from the subject's cultural background
Origin/Source	Describes where the resource is located, who the owner/creator, and/or culture the resource is from
Date – Event	When subject of resource occurred
Name - Creator	Name of resource creator
Date – Created	Date of resource creation
Name - Subject	Name of the subject of the resource
Name – Object	Name or title of the object

TABLE 2E. STATISTICAL COMPARISON OF METADATA CATEGORY FREQUENCY OF TEACHER USED AND RANDOMLY SELECTED RESOURCES.

	Random museum resources		Teacher used resources			
	Mean	SD	Mean	SD	t-statistic	r-effect size
Origin/Source	92.12%	0.25	76.26%	0.42	4.16**	0.28
Name – Creator	73.40%	0.436	63.31%	0.482	2.08**	0.13
Name – Subject	82.93%	0.358	96.40%	0.168	4.16**	0.23
Date – Created	74.15%	0.428	82.73%	0.374	1.67*	0.09
Name – Object	85.57%	0.348	82.73%	0.374	0.66	0.04
Cultural Context	9.85%	0.301	56.12%	0.497	9.82**	0.56
Basic Description	9.27%	0.294	23.74%	0.428	3.44**	0.22
Historical Context	7.80%	0.27	46.76%	0.5	8.36**	0.52
Date – Event	5.47%	0.228	18.71%	0.392	3.59**	0.25
Detailed Description	5.47%	0.23	41.73%	0.495	8.09**	0.52
Impact and Analysis	4.48%	0.21	43.88%	0.498	8.84**	0.56
*p<.05 **p<.001						

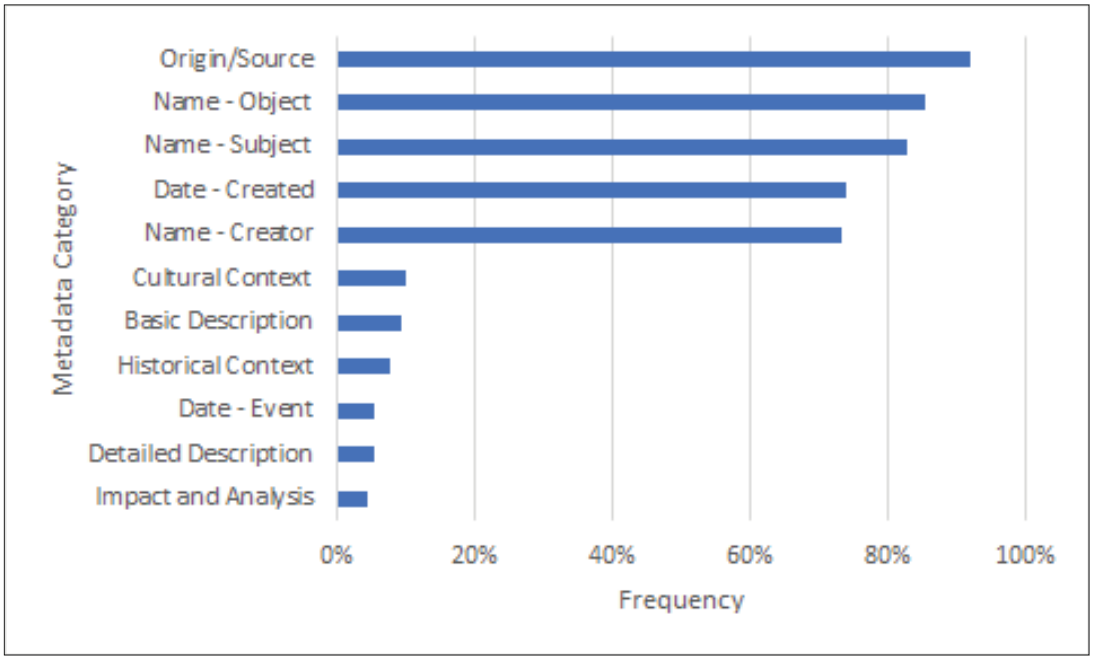


Figure 1E. Metadata category frequency rates for randomly selected museum resources.

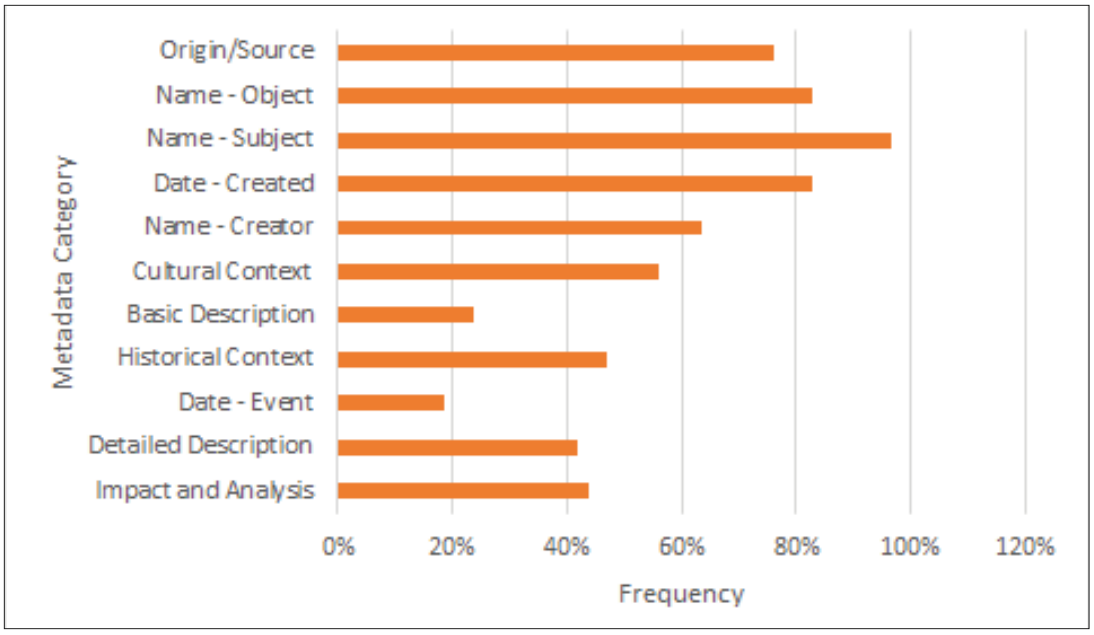


Figure 2E. Metadata category frequency rates for teacher used museum resources.

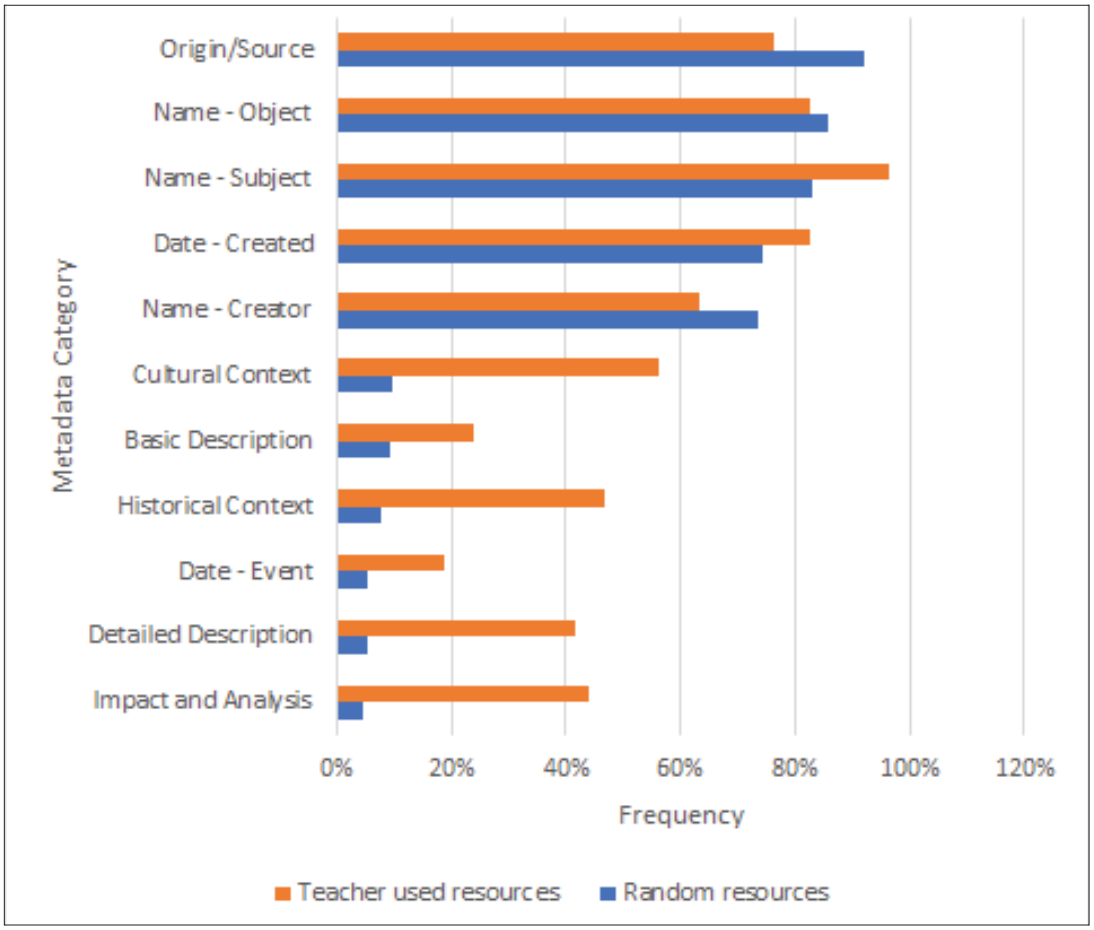


Figure 3E. Comparison of teacher metadata frequency by category of teacher used and randomly selected resources.

Appendix F
Collections Screening in the Smithsonian Learning Lab Reveals Citation and Sensitive Material Concerns

Abstract

One of the Smithsonian Learning Lab's unique features—offering users the ability to upload digital resources along with Smithsonian content to curate personalized collections—is also one of its most challenging aspects to manage under the current system configuration. A daily systematic screening of user-created, published collections revealed two areas for further system improvement: additional support for citations and metadata, and curatorial publishing guidance and criteria for sensitive content.

Introduction

From its inception, the Smithsonian Center for Learning and Digital Access committed to maintain the integrity of the Lab. Dedicated staff and digital volunteers screen each user-created published collection for suitability and review its content—including all annotations. Screening collections occurs daily, reviewing collections against a rubric to determine if content is: "off-topic, partisan-political, contains personal attacks or expletives, or is otherwise abusive, threatening, unlawful, harassing, discriminatory, libelous, obscene, false, pornographic, or infringes on the rights of any third party." The Lab's Frequently Asked Questions (SCLDA, 2016) compliment the Smithsonian's Terms of Use[30] (TOU) for digital content, and are communicated to site users both when users create accounts, and can be accessed in the Help permanent footer on the Lab. From November 2016–May 2017, the screening process of user-generated published content surfaced two issues: proper citation of media and uploading sensitive materials. These concerns offer additional opportunities to provide teacher and student support for Lab users.

Case Presentation

Users who discover resources in the Lab may create collections, which can be a blended compilation of Smithsonian and non-Smithsonian resources. There are two sources of resources in the Lab:

1. Resources generated by the Smithsonian through its official assemblage of online databases, which are generated by the Smithsonian museums, units, or programs. They may be videos, digital images, or PDFs, and have associated metadata—fields entered by the museums themselves to provide provenance and context to the resource; and

30. For more information, see Terms of Use: https://www.si.edu/termsofuse

2. Resources uploaded by users—either a URL link or a file—which are created by teachers, students, and general users of the Lab. Users may combine one or more resources, and their associated metadata, to create a collection. Any user who signs up for a Lab account can upload resources and create collections.

The Lab encourages users to contribute their own materials; however, while metadata tagging is encouraged, users are not required to include it when uploading their own content. Moreover, the metadata fields for users in the Lab are not complete, nor do they follow a standardized citation format (such as APA or MLA). This results in many user-generated resources without proper attribution in the Lab, which may inadvertently constitute copyright and TOU violations, or even claims of plagiarism.

Additionally, some of the user collections without proper citation contain sensitive material. Although not technically a TOU violation, improper citation does affect the quality and usability of a collection, and what might constitute appropriate curation of content. Users may not appreciate that when they choose to publish a collection, their collection is viewable by any Lab user and is indexed by Internet search engines. Visitors who physically attend a museum exhibition about a provocative topic may expect to see sensitive material, whereas visitors to a website may not have those expectations—without fair warning, citation, or metadata.

Summary

The Lab benefits its users by empowering them to curate their own collections. ISTE standards (International Society for Technology in Education, 2017) encourage students to demonstrate an understanding and respect for intellectual property, while the Language Arts standards (Common Core State Standards, 2017) require students to cite sources. While many users may be familiar with traditional literary citation standards, users may not be familiar with citing new media. Supporting collections with a digital citation tool and metadata tagger would reinforce scholarly standards, helping both teachers and students to uphold intellectual rigor and comply with the Lab Terms of Use.

Additionally, the Lab should develop a criterion of excellence to help users decide when to publish their collections. This rubric might include proper citation and metadata as well as content selection and placement. To address the unique issues associated with sensitive materials, the Lab could provide curatorial strategies akin to creating a red frame around a sensitive photograph in an exhibition, as has been done by some museums.

When utilized together, proper citation and metadata tagging of user-generated content, including sensitive materials, create a powerful academic resource for teachers and a critical thinking experience for students. Implementation of these tools and strategies would further leverage the academic effectiveness of the Lab.

Bibliography

References

Abbott, F., & Cohen, D. (2015). Using large digital collections in education: Meeting the needs of teachers and students. *Digital Public Library of America.* Retrieved from https://dp.la/info/wp-content/uploads/2015/04/Using-Large-Collections-in-Education-DPLA-paper-4-9-15-2.pdf

Allen, I. E., & Seaman, J. (2005). Growing by degrees: Online education in the United States. Copyright ©2005 by Sloan-C TM; Retrieved from https://www.researchgate.net/publication/277792423_Growing_by_Degrees_Online_Education_in_the_United_States_2005

American Association of School Librarians. (2007). *Standards for the 21st-century learner*. Retrieved from http://www.ala.org/aasl/sites/ala.org.aasl/files/content/guidelinesandstandards/learningstandards/AASL_LearningStandards.pdf

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, 9(1), 71–88. Retrieved from http://www.citejournal.org/volume-9/issue-1-09/general/examining-tpack-among-k-12-online-distance-educators-in-the-united-states/

Association of American Publishers. (2015). *Learning resource metadata initiative (LRMI).* Retrieved at http://publishers.org/our-markets/prek-12-learning/learning-resource-metadata-initiative-lrmi

Azevedo, R., Moos, D. C., Greene, J. A., Winters, F. I., & Cromley, J. G. (2008). Why is externally-facilitated regulated learning more effective than self-regulated learning with hypermedia? *Educational Technology Research and Development*, *56*(1), 45–72.

Baker, J. (2008). *Introduction to open educational resources*. Retrieved from https://oerknowledgecloud.org/sites/oerknowledgecloud.org/files/OpenResources.pdf

Bergson-Michelson, T. (2012, March 20). Building good search skills: What students need to know. *KQED News*. Retrieved from https://ww2.kqed.org/mindshift/2012/03/20/building-good-search-skills-what-students-need-to-know/

Brush, T. A., & Saye, J. W. (2002). A summary of research exploring hard and soft scaffolding for teachers and students using a multimedia supported learning environment. *The Journal of Interactive Online Learning*, *1*(2), 1–12. Retrieved from http://www.ncolr.org/jiol/issues/pdf/1.2.3.pdf

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).

Chen, K., Dörk, M., & Dade-Robertson, M. (2014). Exploring the promises and potentials of visual archive interfaces. *iConference 2014 Proceedings*, 735–741. https://doi.org/10.9776/14348

Common Core State Standards Initiative (CCSS). (2017). *English language arts standards » Writing » Grade 7 » 6*. Retrieved from http://www.corestandards.org/ELA-Literacy/W/7/6/

Corrigan, P. T. (2013, September 2). Student engagement and learning. In J. C. Hughes and J. Mighty (Eds.), *Taking Stock: Research on Teaching and Learning in Higher Education* (chapter 8). Retrieved from https://teachingandlearninginhighered.org/2013/09/02/jillian-kinzie-student-engagement-and-learning/

Drucker, J. (2013). Is there a "digital" art history? *Visual Resources: An International Journal of Documentation*, *29*(1-2), 5–13. http://dx.doi.org/10.1080/01973762.2013.761106

Egger, S., Hossfeld, T., Schatz, R., & Fiedler, M. (2012). Waiting times in quality of experience for web based services. *2012 Fourth International Workshop on Quality of Multimedia Experience IEEE*, 86–96. Retrieved from http://doi.org/10.1109/QoMEX.2012.6263888

Finn, J. D., & Zimmer, K. S. (2012). Student engagement: What is it? Why does it matter? In S. L. Christenson, A. L. Reschly, and C. Wylie (Eds.), *Handbook of Research on Student Engagement*, 97–131. Retrieved from http://doi.org/10.1007/978-1-4614-2018-7_5

Google Analytics. (2017). *Learning lab: All web site data* [Data file]. Retrieved at https://analytics.google.com/analytics/web/#embed/report-home/a15983249w88554747p91970472/

Granata, K. (2017). Ten digital literacy resources for teachers. *Education World*. http://www.educationworld.com/a_lesson/ten-digital-literacy-resources-teachers.shtml

Great Schools Partnership. (2016). Student engagement. *The Glossary of Education Reform for Journalists, Parents and Community Partners*. Retrieved from http://edglossary.org/student-engagement/

Handler, B. (2010). Teacher as curriculum leader: A consideration of the appropriateness of that role assignment to classroom-based practitioners. *International Journal of Teacher Leadership*, 3(3), 32–42. Retrieved at http://webdata.psru.ac.th/~pisut/tims%20file/teachers%20l%20file/Teacher%20as%20Curriculum%20Leader.pdf

Hernández-Ramos, P., & De La Paz, S. (2009). Learning history in middle school by designing multimedia in a project-based learning experience. *Journal of Research on Computing in Education*, *42*(2).

Hilbert, M. (2011, February 11). How much information is there in the world? *ScienceDaily*. Retrieved from https://www.sciencedaily.com/releases/2011/02/110210141219.htm

Hylen, J. (2007). *Open educational resources: Opportunities and challenges*. Retrieved from https://www.oecd.org/edu/ceri/37351085.pdf

International Society for Technology in Education (ISTE). (2017). *ISTE standards for students*. Retrieved from https://www.iste.org/standards/standards/for-students

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge (TPACK)? *The Journal of Education*, *193*(3), 13–19.

Koehler, M. J., Shin, T. S., & Mishra, P. (2011). How do we measure TPACK? Let me count the ways. *Educational Technology, Teacher Knowledge, and Classroom Impact: A Research Handbook on Frameworks and Approaches*, 16–31. http://dx.doi.org/10.4018/978-1-60960-750-0.ch002

Lindquist, T., & Long, H. (2011). How can educational technology facilitate student engagement with online primary sources? *Library Hi Tech*, *29*(2), 224–241.

Notess, G. R. (2007). Teaching web search skills: Techniques and strategies of top trainers. Medford, NJ: Information Today, Inc.

Ritchhart, R. (2007). Cultivating a culture of thinking in museums. *Journal of Museum Education*, *32*(2), 137–153. http://dx.doi.org/10.1080/10598650.2007.11510565

Singer, N., & Ivory, D. (2017, November 3). How Silicon Valley plans to conquer the classroom. *The New York Times*. Retrieved from https://www.nytimes.com/2017/11/03/technology/silicon-valley-baltimore-schools.html?_r=1

Smithsonian Center for Learning and Digital Access (SCLDA). (2016). *Frequently asked questions (FAQs)*. Retrieved from https://learninglab.si.edu/help/faqs.

Smithsonian Institution (SI). *Terms of use*. (2016). Retrieved from https://www.si.edu/termsofuse

Sobel, K., & Grotti, M.G. (2013, November 22). Using the TPACK framework to facilitate decision making on instructional technologies. *Journal of Electronic Resources Librarianship*, *25*(4), 255–262. Retrieved from http://dx.doi.org/10.1080/1941126X.2013.847671

Zinger, D., Naranjo, A., Amador, I., Gilbertson, N., & Warschauer, M. (2017). A design-based research approach to improving professional development and teacher knowledge: The case of the Smithsonian Learning Lab. *Contemporary Issues in Technology and Teacher Education*, *17*(3), 388–410. Retrieved from http://www.citejournal.org/volume-17/issue-3-17/general/a-design-based-research-approach-to-improving-professional-development-and-teacher-knowledge-the-case-of-the-smithsonian-learning-lab/

Related References

Ash, K. (2013). 'Personal learning environments' focus on the individual. *Education Week*, 32(32), S32–S34. Retrieved from https://www.edweek.org/ew/articles/2013/05/22/32el-personallearning.h32.html

Bragg, M., Chapman, J., DeRidder, J., Johnston, R., Junus, R., Kyrillidou, M., & Stedfeld, E. (2017, October 9). Best practices for google analytics in digital libraries. Retrieved from http://doi.org/10.17605/OSF.IO/CT8BS

Duff, W. M., Yakel, E., Tibbo, H. R., Cherry, J. M., McKay, A., Krause, M. G., & Sheffield, R. (2010). The development, testing, and evaluation of the archival metrics toolkit. *The American Archivist*, *73*, 569–599. Retrieved from http://americanarchivist.org/doi/pdf/10.17723/aarc.73.2.00101k28200838k4

Fraser, B. T., McClure, C. R., & Leahy, E. H. (2002). Toward a framework for assessing library and institutional outcomes. *Libraries and the Academy*, *2*(4), 505–528. Retrieved from https://doi.org/10.1353/pla.2002.0077

Hamilton, E., & Jago, M. (2010). Toward a theory of personalized learning communities. In Jacobson M., Reimann P. (Eds.), *Designs for learning environments of the future* (pp. 263–281). Boston, MA: Springer.

Harris, K. (2017, May 23). *Teach students to curate a project 'playlist' with primary-source documents*. Retrieved from https://www.iste.org/explore/articleDetail?articleid=970&category=In-the-classroom&article=Teach+digital+curation+with+depth

Heitin, L. (2016). Digital literacy: An evolving definition. *Education Week*, *36*(12), 5–6. Retrieved from http://www.edweek.org/ew/articles/2016/11/09/what-is-digital-literacy.html

Kelly, B. (2012). *Evidence, impact, metrics: Final report*. Retrieved from http://opus.bath.ac.uk/32789/

Meyer, E. T. (2011). *Splashes and ripples: Synthesizing the evidence on the impact of digital resources*. Retrieved from https://ssrn.com/abstract=1846535

Milligan, D., Wadman, M., & Ausland, B. (2017, February 1). Discovering, creating, and sharing digital museum resources: A methodology for understanding the needs and behaviors of student users. *MW17: MW 2017*. Retrieved from https://mw17.mwconf.org/paper/discovering-creating-and-sharing-digital-museum-resources-a-methodology-for-understanding-the-needs-and-behaviors-of-student-users/

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054. Retrieved from http://onlinelearningcurriculumcommittee.pbworks.com/f/mishra.pdf

Palak, D., & Walls, R. T. (2009). Teachers' beliefs and technology practices: A mixed methods approach. *Journal of Research on Technology in Education*, *41*(4), 417–441. Retrieved from http://doi.org/10.1080/15391523.2009.10782537