Design and Development of a Performance Support Tool for the Digital Curation of Non-Textual Learning Objects

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Dissertation Submitted to faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Curriculum and Instruction
(Instructional Design and Technology)

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March 17, 2016
Blacksburg, Virginia

Keywords: Instructional technology, metadata, knowledge harvesting, performance support, non-textual learning objects

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ABSTRACT

As more artifacts are created in a digital format, there is a need to have metadata associated with the artifacts to increase the chance for resource discovery by others. This is especially the case with non-textual artifacts. Once these artifacts have descriptive metadata associated with them, they have the potential to become learning objects which can be used by others in their own teaching and research. This study explored the design and development of a performance support tool to create descriptive metadata by users that are most familiar with the non-textual learning objects, yet may not have an understanding of the various metadata schemas and standards required by other institutional/knowledge repositories and search engines.

In order to create such a tool, certain features need to be included in order for users to create appropriate metadata. The tool needs to have Unicode character support in order metadata entry, display and searching. Research found that characteristics such as controlled vocabularies, tooltips, validation rules, and having a relevant image on the same screen as the metadata form help users to create appropriate and accurate metadata; yet, no existing tool was found that contained all of these features to assist faculty in describing their non-textual learning objects.

These characteristics were operationalized in the design and development of the performance support tool. Findings from the evaluation of the tool indicate that the owner of the learning objects was able to create a customized, non-standard metadata form that users were then able to use to create appropriate and accurate descriptive metadata.

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GENERAL AUDIENCE ABSTRACT

As more information is being created, or converted to, a digital format, there needs to be metadata associated with the digital artifact. Metadata is the information that describes the artifact. Metadata is needed especially for non-textual artifacts such as photographs, maps, film, 3-d images, etc. because without the metadata to describe it, search engines would not find the artifact so that others could discover the artifact and re(use) it. This study explored the design and development of a tool that would assist users that have knowledge about the artifact to create the metadata. These artifacts could then become learning objects, because once the metadata has been created then the chance of discovery increases which allows instructors to use them in their own teaching or research.

Acknowledgements

I can do all things through him who strengthens me. – Philippians 4:13. First and foremost, I thank God for the many blessings he has bestowed upon me in all areas of my life. God has placed so many amazing people in my life, who have all inspired me and helped me to develop into the person I am today. Through Him, all things are possible.

I would like to thank each of my committee members: Dr. Ken Potter, Dr. Barbara Lockee, Dr. John Burton, and Dr. Aaron Bond. They attended each meeting with positive attitudes and were quick to offer their encouragement and support. A special thanks to Dr. Potter for his patience during the entire process and for helping me to find the path when I wandered astray and for being supportive of my interest in pursuing a research focus, despite it being outside the box of conventional dissertation research designs.

To my nieces, Kaitlin and Laurin, thank you for always asking about my 'book'. I hope I have inspired you with the knowledge that learning is a lifelong process, and through perseverance and self-determination, you can accomplish anything you decide is worth achieving. It is important that you always remember never to give up on your dreams.

Last, but not least, I am indebted to my husband, Rob, for his unconditional love and moral support. Thank you for listening when you didn't have to, knowing when not to listen, and continuously providing support and understanding throughout this process. Your belief in me and what I could accomplish never wavered, even when I did. I love you with all my heart.

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Chapter 1: Introduction

As more data are created in, or converted to, digital formats due to advancement in technologies, many businesses, government entities and higher education facilities are now faced with the daunting task of figuring out how to organize the massive amount of digital information they have accumulated in order to efficiently locate and use it when needed (Schacht & Maedche, 2016; Zeng, 2008). The key component of that statement is being able to locate and use it when needed because "…the best 'information' content in the world is of no value at all unless it is effectively, efficiently, accurately, and simply 'communicated'" (Scott, Saunders, Palacios, Nguyen, & Ali, 2012, p. 325).

A statement from the Library of Congress (n.d.) exemplifies the potential for the massive amount of digital data available in that it took two centuries to acquire its 29 million books and 105 million other items, but today it takes 15 minutes for the world to produce an equivalent amount of information digitally. As a society, we have become so accustomed to looking for information online that we often forget to consider how it got there or where it originated. As Mark Weiser, a Xerox computer scientist, stated in 1991: "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" (Weiser, 1991, p. 94). Photography is an example of this phenomenon. Rarely does one think about bringing a camera to an event or function, because we already have it with us; our digital camera is embedded right in our cell phone. Digital cameras, which are closely tied to computer technology, have become powerful, inexpensive, and pervasive in nature (Passmore, 2008). This is demonstrated by the fact that it is estimated that there are around 380 billion photographs taken each year and that number is expected to grow to 880 billion in 2014 ("The Big Picture," 2013).

This digital content being created can have many different uses; an example of this is a learning object for instructional material or research. Learning objects have become a common format for developing and sharing digital educational resources, especially when it comes to technology-enhanced learning (Sampson & Zervas, 2013). For the purposes of this study, a learning object will be defined as any resource that is, or can be, digitized and can be (re)used to support learning. A learning object is based upon the characteristics of granularity and reusability. Granularity refers to the size of the resource; the smaller the resource, the higher the level of granularity (Littlejohn, 2003). For a learning object, that means taking the large learning material used for a course and cutting it into several smaller independent chunks (Littlejohn, 2003). Another characteristic of a learning object is reusability. As Littlejohn (2003) stated, by creating the smaller, independent chunks – learning objects – one creates the ability to reuse a learning object in more than one course or in more than one way. Learning objects need to be context neutral and stored where they can be shared and reused by others (Sabitha, Mehrotra, Bansal, & Sharma, 2015).

Artifacts, when digitized, frequently function as learning objects. By digitizing an artifact, one is creating potentially greater access to the artifact than it had before, just as when a folktale is written or recorded instead of only communicated orally. When an artifact is digitized, it becomes accessible to others, thereby creating the potential for the artifact to be used in ways that would have been impossible before (Kenney & Rieger, 2000).

When non-textual artifacts are digitized, they can be repurposed for a wide range of uses, including teaching, research, and publishing. However, the process of digitizing an artifact alone is not enough to ensure resource discovery by others. This is where metadata can play an important role. This is especially true for non-textual artifacts as metadata create structure and meaning for the artifact where it did not exist before. The main role of metadata is to describe the artifact, which is then used to aid in the discovery of the relevant information (Haynes, 2004; Hudgins, Agnew, & Brown, 1999; National Information Standards Organization (U.S.), 2004).

When using metadata to describe non-textual artifacts, one needs to consider who should create the metadata. The most well-known category of metadata creator is that of information specialists, more commonly known as professional catalogers (Greenberg, 2000). Information specialists are professional catalogers who have a very detailed knowledge of multiple cataloging rules and standards, such as Machine-Readable Cataloging (MARC), Dublin Core (DC), Encoded Archival Description (EAD), Learning Object Metadata (LOM), and the Visual Resource Association's Core (VRA), among others (Hillmann, 2004). At the same time, information specialists may not be familiar with the content of the artifacts they are cataloging, which may be especially true for non-textual artifacts (Crystal & Greenberg, 2005; Hillmann, 2004). Opposite the information specialists are the knowledge producers who may not be familiar with cataloging standards, but have in-depth knowledge of specific artifacts and, potentially, an awareness of the type of users that will be searching for, or interested in finding specific types of objects. Nevertheless, there are concerns that creation of metadata by knowledge producers instead of information specialists may result in some problems with the metadata, including: (1) incorrect subject headings, (2) missing data, (3) data added to incorrect fields which could result in the object not being found when searched, (4) syntax errors for the schema that could cause the metadata to not be processed, and (5) using terminology that is inconsistent with the metadata schema (Beall, 2005; Currier, Barton, O'Beirne, & Ryan, 2004; National Information Standards Organization (U.S.), 2004). Since a major function of metadata use is to promote resource discovery, the more detailed and meaningful the metadata are for an artifact, the greater the chance of others finding and (re)using the artifact (Beall, 2005).

Need for the Study

In order to promote resource discovery for non-textual artifacts, accurate and relevant metadata are needed by those that are the most familiar with the non-textual artifact. As a result, there is a need for knowledge producers to create metadata for non-textual artifacts without requiring an understanding of the rules and procedures used by information specialists in cataloging in order to promote resource discovery for artifacts and (re)use by others. This need exists due to the increasing amount of new, non-textual artifacts that are being created daily in a digital format and for artifacts that currently exist, or have been converted to a digital format, without the associated metadata.

Without metadata, non-textual digital images are likely to remain as little more than a list of files stored in some location, because without descriptive metadata the likelihood of discovery by others is slim due to the fact that virtually all search access is through the metadata (Beall, 2005). By creating descriptive metadata for these non-textual artifacts, each artifact then has the potential to become a learning object used by others. Metadata need to be created by those that have knowledge about the artifacts in order to increase the potential that these artifacts could become learning objects for others to find and then share, (re)use and re-purpose for other learning environments (Greenberg, 2002). When learning objects are made available for others to use "…people you would never have expected find these materials from sometimes very strange and exotic places that you wouldn't have imagined, and sometimes make extraordinarily creative or unpredicted uses of that material" (Lynch, 2002, p. 137). For that reason, the artifacts used in this study, will thus forward be called learning objects.

Purpose Statement of the Study

The purpose of this study was to design and develop a performance support tool for knowledge producers to create metadata for non-textual learning objects. A performance support tool prototype was designed and developed that allowed knowledge producers, who may not have an in-depth understanding of metadata schemas and cataloging rules, to create such metadata. Knowledge producers, for the purpose of this study, are considered to be users that have knowledge of, but are not necessarily considered experts regarding, the non-textual learning objects, and may or may not be the originator of the learning objects. In this study, knowledge producers used the performance support tool to create metadata for the learning objects, which could then be imported into a knowledge repository to better facilitate searching and discovery of those objects and afford potential reuse by other instructors and/or researchers. This process allowed the learning objects to be shared and used by others, since "Through communal material sharing, every member has access to a much greater amount of resource than can ever be produced individually" (Nurmi & Jaakkola, 2006, p. 271).

The study design consisted of four main phases: analysis, design, development, and evaluation. This study followed a developmental research methodology, specifically tool development. Developmental research is defined as the "systematic study of design, development, and evaluation processes with the aim of establishing an empirical basis for the creation of instructional and non-instructional products, tools, with new or enhanced models that govern their development" (Richey & Klein, 2007, p. 1). Developmental research is an appropriate methodology for this type of study as researchers in the field of instructional design and technology should be "studying design, development, and evaluation as well as doing it" (Richey & Klein, 2007, p. 6).

Research Questions

In this study, the following questions guided the study:

1. What characteristics and/or features would contribute to the design and development of a performance support tool to allow knowledge producers to create metadata for non-textual learning objects?
2. How might the characteristics and/or features of a tool be operationalized to allow knowledge producers to create metadata for non-textual learning objects?
3. What are the lessons that can be learned from the design and development of a performance support tool?

Benefits of the Study

As more non-textual learning objects are created in a digital format and made available to others, the metadata associated with each non-textual learning object become critical components for the discovery of the learning object (Haynes, 2004; Hudgins et al., 1999; National Information Standards Organization (U.S.), 2004). Since knowledge producers should be more familiar with the non-textual learning object than the average person who has never seen the learning object, they would be the appropriate ones to provide the necessary metadata. Yet, they may not be familiar with the metadata schemas required by knowledge repositories to create collections for learning objects. Thus, a performance support tool could improve the relevance and quality of metadata generated for non-textual learning objects so that those learning objects could then be more easily discovered, used, and potentially reused for other purposes by researchers, students, and/or the community at large.

Assumptions and Limitations

This study assumed that the owner possessed sufficient subject-specific knowledge to provide the type of fields/tags/elements required for the needed metadata and any controlled vocabularies associated with metadata terms. This study was limited to the design, development and testing of a tool that allowed knowledge producers to create metadata for learning objects using the tool. The study did not focus on the ability to search for and find the learning objects once the metadata were created. This study was also limited to the design, development, and testing of the performance support tool prototype as it was developed to demonstrate its feasibility as a tool to collect metadata for non-textual learning objects

Organization of the Proposed Study

Chapter One consists of an overview of the problem, the need for the study, the purpose of the study, the guiding research questions, and the assumptions and limitations. Chapter Two contains an extensive review of the literature, including benefits of reusing non-textual learning objects, different types of metadata and why they are needed, who should create the metadata, complications involved with creating metadata, and the design features desirable for developing a tool to collect metadata. Chapter Three describes the design and development methodology and the model that was used to conduct the study. This chapter also includes a detailed description of the four phases followed in order to conduct the study, as well as a description of the participants and setting, data analysis, and ethical considerations. Chapter Four addresses the findings of the study. Chapter Five discusses the lessons learned from the study and conclusions about the performance support tool.

Chapter 2: Literature Review

This chapter addresses the research on how to increase the likelihood of the reusability of non-textual digital learning objects for instructional purposes by using an advanced, customized, and user-friendly performance support tool to create descriptive metadata for those objects. This chapter contains five sections. The first section provides a brief background on learning objects and the importance of granularity, followed by issues of accessibility. The literature review continues with the benefits to repurposing and reusing non-textual learning objects. The chapter continues with an explanation of metadata and different types of metadata and why metadata are needed, especially for non-textual learning objects. The discussion also addresses who should create metadata and issues involved with the creation of the metadata followed by a discussion on the absence of performance support tools. The literature review ends with an examination of how knowledge is harvested from people to generate the descriptive metadata needed for the non-textual learning objects.

What are Learning Objects?

The term 'learning object' has many different uses and definitions. Use of the term was popularized in 1994 by Wayne Hodgins in association with object-oriented programming "…when he named the CedMA [sic; Computer Education Management Association] working group 'Learning Architectures, APIs and Learning Objects'…" and "…has become the Holy Grail of content creation and aggregation in the computer-mediated learning field" (Polsani, 2003, p. Abstract section, para. 1).

The multitude of definitions of the term adds to the confusion about exactly what constitutes a learning object (Nurmi & Jaakkola, 2006; Polsani, 2003). A very broad definition for a learning object is "…any entity, digital or non-digital, that may be used for learning, education or training" (Learning Technology Standards Committee of the IEEE Computer Society, 2002, p. 3). Wiley (2002) however, felt this definition was too broad and defined a learning object as "any digital resource that can be reused to support learning" (p. 6). Polsani (2003), on the other hand, felt that a learning object was best defined as "...an independent and self-starting unit of learning content that is predisposed to reuse in multiple instructional contexts" (p. 32) and South & Monson (2002) defined a learning object as "…digital media that is designed and/or used for instructional purposes" (p. 223). In the corporate environment, the term reusable learning object is used quite frequently and is defined as "based on a single learning or performance objective, built from a collection of static or interactive content and instructional practice activities" (Cisco, 2003, p. 6).

For the purposes of this study, a learning object will be defined as any resource that is, or can be, digitized and can be (re)used to support learning. Learning objects embody reusable knowledge since, once they are created, they can be shared, disseminated, and applied by other users (Dalkir, 2011). Some examples of learning objects include images, text, video or audio clips, and animations. Ideally, these resources would be designed so that they could be adapted to fit different educational needs (Littlejohn, 2003; Wiley, 2002). When considering the potential reuse of learning objects, there are two important characteristics of the learning objects to consider: granularity and the accessibility.

Granularity

Granularity refers to the size of the learning object - the smaller the object, the higher the level of granularity (Littlejohn, 2003). The size of the learning object is vital for achieving success in its reusability (Polsani, 2003). Kim (2009) identified five levels of granularity. . Level 5 had the least level of granularity as it contained the most information, i.e., several lessons or modules in a course and would be more difficult for others to incorporate into their own instructional material (Kim, 2009). Kim (2009) went on to explain that the next level of granularity, level 4, could be a lesson or module, and may consist of several units, followed by level 3, which would be a unit, which consists of several combined units, such as a learning objective with content, practice, and assessment. The next highest level - level 2, contains combined media, such as text with a combination of media (image, sound, animation, etc. with the highest level of granularity (level 1) being an asset which consists of a single learning object, such as a text, image, sound, etc. (Kim, 2009).

The more granular the learning object, such as an individual image, the greater the chance that others will be able to reuse that object in their own instructional material as opposed to a large resource such as an entire course module (Littlejohn, 2003). Learning objects have the greatest potential for reuse when they center on a single core concept, this way they can easily be used in another context while retaining their instructional utility (South & Monson, 2002). Yet, teachers may view using larger resources (and thus less granular), such as a complete learning activity, in their instructional material instead of creating the same learning activity from small components as less time consuming for them (Littlejohn, 2003). Then again, learning objects with the highest level of granularity have the greatest chance of being (re) used by others (South & Monson, 2002). This also helps to minimize the duplication of effort for teachers across subject areas and provides a wider variety of learning materials (Currier et al., 2004).

Accessibility

Even if learning objects are digitized and easy for faculty, students and the community to use, they are of limited value if they cannot be accessed. In this technologically advanced age, faculty frequently create files and harvest images they need for their classroom or research agendas and store them on their own laptops and/or memory devices, usually with a minimum of descriptive information and where no one else is able to use them (Kohl, 2010). Peters & Dryden (2011) did a pilot study in which they interviewed ten primary investigators from eight different departments on a university campus about their data management practices for research they were currently conducting. "In regard to data storage, numerous methods were used by everyone interviewed, the most common being storage on a PC hard drive" (Peters & Dryden, 2011, p. 393). Peters & Dryden (2011) also noted, "Five respondents indicated that they have no real file or folder naming conventions in place, with students often being left to their own devices in terms of data organization." (p. 395) and "…none of the interviewed individuals indicated using any formal metadata standards…" (p. 395). The interviewees also reported that they did not consider sharing of their data with others and one of the reasons cited for this was the time and effort required to make the data available (Peters & Dryden, 2011). Storing these learning objects locally (on their own computer or memory device) limits the accessibility by others wanting to find and use these same learning objects for their own teaching or research (Wiley, 2005).

Sharing of resources has the potential to promote a consistency for instructional material created within a group and allows other researchers to expand upon existing research or (re)use it to create a new research topic (Brown, 2006; Buckland, 2011; Daly & Ballantyne, 2009; Hughes, 2004; Rademaker et al., 2015). Buckland (2011) stated, "The potentially useful record of science is increasingly not the written reports but (mainly non-textual) digital data set of many kinds…" (p. 35) which can be "…beneficially shared and built upon by other researchers" (p. 35). When researchers are unable to discover, access, and utilize each other's learning objects, the chance for data sharing and (re)use between researchers diminishes which becomes an issue:

> Members of the university community are rapidly becoming accustomed to using digital objects in their teaching and research. They have their own content (both digital and not-yet-digital), and they seek additional content relevant to their work" (Attig, Copeland, & Pelikan, 2004, p. 251).

Another potential accessibility issue occurs when faculty members leave universities and have not contributed their research and/or teaching materials to a central repository. In such cases, they may take their instructional materials (and thus potential learning objects) with them and replacement faculty members must figure out a way to fill the gaps created by not having access to those learning objects. This not only creates a redundancy of work, but also the continuity for course material is lost (Kohl, 2010). Storing learning objects in some type of repository, accessible by others, provides the ability so that "…teachers, course developers and learners can share, reuse and re-purpose digital materials for incorporation into teaching and learning" (Currier et al., 2004, p. 5).

Repurposing and reuse of learning objects

Repurposing, reuse, and accessibility go hand in hand. Either repurposing or reuse of learning objects is possible only when learning objects are accessible. Accessibility requires both technological means as well as informational means. When a non-textual learning object assumes a digital form via technological means, its potential for repurposing or reuse increases because it affords a greater opportunity for access (Bernard et al., 2015; Brown, 2006; Hillmann, 2004). To illustrate this, if one were researching original, non-digital documents and objects associated with Abraham Lincoln, one would need to visit the National Archives to see the Emancipation Proclamation, the Library of Congress to view the Gettysburg Address, the Smithsonian to see Lincoln's hat, and also travel to Illinois to see his sofa. If one is willing to utilize digital forms of these documents and objects, they can all be accessed by searching online repositories (Lesk, 2015).

A combination of hardware and software make an online search technologically possible while descriptive metadata associated with the documents and objects provide the informational means needed to access the relevant files. The topic of metadata is discussed later in this chapter.

Reusability

Digitizing learning objects is one approach to preserving the materials used today for repurposing and reuse by future generations. "The ability to share and reuse parts of formalized bodies of knowledge is vital to the management and preservation of knowledge" (Hillmann, 2004, p. 199). Making data accessible and searchable to others encourages reuse (Poole, 2014; Schofield et al., 2009). Preserving and providing access to these learning objects for others to reuse and repurpose have considerable benefits, as can be seen in a statement from the National Science Foundation (2009):

> Digital data are increasingly both the products of research and the starting point for new research and education activities. The ability to re-purpose data – to use it in innovative ways and combinations not envisioned by those who created the data – requires that it be possible to find and understand data of many types and from many sources (para. 4).

Another benefit to digitizing is the ability to reuse learning objects that would be impossible to reproduce, too costly to regenerate, or difficult to access (Brown, 2006; Ross & Hedstrom, 2005; Wiley, 2005).

A study by Benoit and Hussey (2011) provides an example of reusability, where they examined how four publishing companies use digital objects to redeploy assets already existing within their company. For example, one publishing company used existing digital images from already published history and art history texts to create a chapter in an introductory high school French language textbook by using existing historical pictures of Charles De Gaulle and the Eiffel Tower (Benoit & Hussey, 2011).

Digitizing non-textual learning objects not only preserves access to them for future generations, but also provides the potential for research collaboration or new research, which could reach a larger and a more diverse audience, based upon existing learning objects within a department, university or across institutions (Brown, 2006; Daly & Ballantyne, 2009; Hughes, 2004; Rademaker et al., 2015).

"A resource that can be made to benefit more than one group yields a greater return on investment" (Buckland, 2011, p. 35). Boyle and Cook (2003) discussed the economic and pedagogical reasons for capturing resources (such as non-textual learning objects) in a way that facilitates their reuse in a variety of settings. Bernard (2015) discussed how non-textual learning objects (such as images, audio-visual material, etc.) can be an invaluable source for scientists of undiscovered knowledge if they can be found and retrieved; , yet, "…more than 60% of publicly funded projects do not yet yield openly accessible resources that can be located via online searches using public search engines" (Di Maio, 2013, p. 23).

Metadata

As the discussion above points out, even with all the data that are being generated digitally, it is not enough for learning objects to just exist in a digital format. For repurposing and reuse to occur, the digital learning objects also must be accessible. As mentioned in an earlier section, accessibility relies on the availability of appropriate technology and relevant information, or metadata.

Relevant metadata are needed in order for others not only to understand the meaning/purpose of the learning objects, but also to promote discovery through searching. As the white paper by Cisco (2003) stated, "…everything found in the learning object is identified with metadata so that it can be referenced and searched both by authors and learners" (p. 6). Even if searching may be becoming more visually based, metadata are still needed in order to support the identification of the learning objects and the discovery of new learning objects (Kress, 2003).

Whether the metadata are embedded within the learning object or stored separately, the primary purpose of the metadata is to facilitate locating a specific item and then its retrieval and display (Campbell, 2005; Chester, 2006; Clyde, 2002). Yet, metadata are used for more than just search and retrieval, "…it also documents how that object behaves, its function and use, its relationship to other information objects, and how it should be and has been managed over time" (Gilliland, 2008, p. 7). This section of the literature review discusses what metadata are and examines five different types of metadata that can exist for a learning object. Lastly, this section will discuss why metadata are needed for learning objects.

What are metadata?

A common definition used to describe metadata are 'data about data', (Gilliland, 2008) but what does that really mean? Haynes (2004) explained metadata as "…data that describes the content, format or attributes of a data record or information resource" (p. 8). Another frequent definition for metadata is that which gives structure to unstructured information (Clyde, 2002; Maxymuk, 2005). A general definition of metadata that seems to encompass many areas is "…structured information that describes, explains, or otherwise makes it easier to retrieve, use, or manage an information resource" (National Information Standards Organization (U.S.), 2004, p. 1).

Metadata are used to describe all types of information, including, but not limited to: web pages, books, journals, and of course digital data, which includes digital images (Haynes, 2004). The richer the metadata content the more diverse the population will be that can utilize the learning objects (Levy, 2007). Metadata can be embedded with the object (as is normally the case for headers of image files) or it can be stored separately from the object (Campbell, 2005; Chester, 2006; Haynes, 2004; National Information Standards Organization (U.S.), 2004). There are advantages to each method. By storing the metadata with the learning object, the metadata will be attached to the learning object and not lost or disconnected from the learning object, which helps promote interoperability because if the learning object is moved to another system or downloaded by a user, the metadata will stay with the learning object (Campbell, 2005; Chester, 2006; Haynes, 2004). Storing the metadata separately can support and optimize the search and retrieval process, even as it increases the risk of the metadata becoming disassociated with the learning object (Campbell, 2005; Chester, 2006; Haynes, 2004).

Different types of metadata

Metadata not only give structure to the data for a learning object, but the metadata also possess different types of structure For example, Maxymuk (2005) defined five different types of metadata: (1) descriptive, which describes the resource for the purpose of discovery and identification, (2) administrative, which contains information to help manage the resource, such as when and how it was created, accessed, controlled, and copyright information, (3) technical, which contains file characteristics about the object such as file format, file size, software used, scanning specifications, etc. (4) structural, which controls the relationships of the parts of a complex object, and (5) preservation, which documents the process used to create the digital object. However, Chester (2006), Gilliland (2008) and the National Information Standards Organization (NISO) (2004) discuss only three different types of metadata: descriptive, administrative, and structural. NISO (2004) does include technical and preservation as subsets to the administrative metadata. A learning object may contain only one type of metadata, as listed above, or all of the different types depending upon the needs of the learning object within the collection. Each of the five different types will be discussed in more detail below.

Descriptive. Descriptive metadata help users find information about particular learning objects, which is why almost all records need to contain a certain amount of descriptive metadata. In order to be able to find and retrieve a learning object, descriptive metadata are essential because "The more highly structured an information object is, the more that structure can be exploited for searching, manipulation, and interrelating with other information objects" (Gilliland, 2008, p. 6). Descriptive metadata are a concern in knowledge management as metadata are needed in order to increase the usability (and reusability) for a given unit of knowledge (Dalkir, 2011).

Descriptive metadata are essential for searching and retrieval, whether the learning object is textual, such as a book, or non-textual, such as a photograph. However, for non-textual learning objects, the metadata are critical as these learning objects rely on the descriptive metadata for discovery and the more detailed the metadata, the greater chance of discovery by the user (Levy, 2007; South & Monson, 2002). A key benefit to digitizing non-textual learning objects is lost if these assets cannot be searched for and retrieved by users, and this is where descriptive metadata are needed, especially when you are talking about tens of thousands of non-textual learning objects that possibly consume terabytes or even petabytes of space (Goodin, 2007).

When creating descriptive metadata for a non-textual learning object, one must also consider the scope of the collection. The metadata need to be created with consideration to how they will be (re)used by others and not just by those for whom the collection may have been originally intended:

> This has been dubbed the 'on a horse' problem, from the description of a photograph in Harvard's Teddy Roosevelt collection, where the title assigned to the photograph did not indicate who was sitting on the horse, since all the materials in the collection related to Roosevelt (Cole, 2002, p. 76).

With the ability for search engines to harvest collections, the descriptive metadata should be created with a global approach in mind.

Administrative. The software used to manage learning objects would normally create administrative metadata since it pertains to the management of the resources (Cole, 2002). The information contained for this type of metadata includes when and how an object was created or modified, who is responsible for access to the content, what processing activities have been performed, and restrictions on access or use (Cole, 2002; Gilliland, 2008; Haynes, 2004; National Information Standards Organization (U.S.), 2004). "Administrative metadata helps collection managers keep track of objects for such purposes as file management, rights management, and preservation" (Cole, 2002, p. 83). Administrative metadata are not normally available for public viewing, but used more by the administrator of the system for management and custodial care of the learning object (Greenberg, 2001).

Technical. Technical metadata contain information related to how the learning object functions or behaves (Gilliland, 2008). For example, if the learning object is a photograph the technical metadata may include the type of camera used, pixels, the compression ratio, GPS coordinates where the photograph was taken, etc. Technical metadata could also include information about authentication or security data, such as encryption keys or passwords (Gilliland, 2008).

Structural. Structural metadata, also known as use metadata, contain information about how the learning object may relate to other objects (Gilliland, 2008). Structural metadata document the relationships among the individual pieces of an object and the complete object (Cole, 2002; Gilliland, 2008; National Information Standards Organization (U.S.), 2004). For example, if a paper is digitized as individual columns, say columns 1-6, the structural metadata contain information concerning the order of the columns that create the main page of the paper. When a user clicks on the main page of the paper, the structural metadata inform the system the order to display the columns so it looks like you are viewing the main page of a printed newspaper and not each individual column.

Preservation. Preservation metadata contain information that tracks the history of the digital learning object, such as where it came from and how it has changed over time, as well as information about the physical characteristics of the learning object (National Information Standards Organization (U.S.), 2004). The purpose of preservation metadata is to ensure that the object survives into the future. As digital information is fragile, it can be corrupted or altered, and can become unusable with the rapid pace of hardware and software changes (Cole, 2002; Gilliland, 2008; National Information Standards Organization (U.S.), 2004). With non-textual learning objects "…digital preservation formats must be able to capture the level of detail that will render the original work as faithfully as possible at some time in the future" (Coyle, 2006, p. 205). Preservation metadata would not be viewable by the public, but are used as more of an administration type of metadata.

Issues with metadata creation

Metadata standards. Metadata standards "…provide guidelines regarding structure, values, and content" (Zeng, 2008, p. 11) and are "set[s] of instructions specifying how something will be done, and they play an important role in the transfer of knowledge from one location to another" (Zimmerman, 2008, p. 632).

There is no one type of metadata that will fit the needs of all learning objects because "…it is not the object itself that determines the metadata but the needs and purposes of the people who create it and those who it will serve" (Coyle, 2005, p. 160). For example, when you arrive in a new city, you might use a map that describes the subway system to understand where the subway can take you, or a road map while driving that highlights attractions in the city, or a trail map that highlights the different elevations and trails. Just as you may need to use different maps for one location, the same can be said for metadata.

Metadata standards act as keys to digital collections by making the collections easier to use and providing the ability to discover the resources. Metadata standards not only benefit users, but also collection developers by providing a consistency for cataloging the resources (Hillmann, 2004).

Common schemas used. Because there is not a single metadata standard that will work for every type of collection or material, an important consideration when creating a collection is to select the most appropriate metadata standard that matches the learning object (Gilliland, 2008). If an appropriate metadata standard is not found for the type of collection to be created, then a custom schema will need to be created to fit the desired metadata. While it would be too exhaustive to describe every metadata standard that exists, it is helpful to describe some of the more common schemas, especially as they relate to non-textual objects, which is summarized in Table 1 below.

Table 1
Metadata Standards

Name	Focus	Description
Encoded Archival Description (EAD)	Archiving	Popular for archival and special collections and is used for finding aids (Maxymuk, 2005; National Information Standards Organization (U.S.), 2004)
Visual Resource Association's Core (VRA)	Arts	Description of works of visual culture as well as the images that document them (Riley, 2010)
Machine-Readable Cataloging (MARC)	Bibliographic	Used in most libraries to describe bibliographic data (Riley, 2010)
Dublin Core (DC) A subset of DC is Unqualified DC and Qualified DC	Networked resources	Unqualified DC means that the metadata only uses the basic fifteen elements or fields provided with DC. For example, a record that used Unqualified DC would only have Date as a metadata element. Qualified DC uses additional qualifiers for the metadata, so Date could also have additional fields, such as, Date Added, Date Last Modified, Date Created, etc.("DCMI Home: Dublin Core® Metadata Initiative (DCMI)," n.d., p. n.d.).
Learning Object Metadata (LOM)	Learning Objects	Used in the description of learning objects. LOM data elements are grouped into nine categories: general, lifecycle, meta-metadata, technical, educational, rights, relation, annotation, and classification (Riley, 2010).
Metadata Encoding and Transmission Standard (METS)	Bibliographic	METS is an XML (extensible markup language) metadata standard (Riley, 2010)
Metadata Object Descriptive Schema (MODS)	Bibliographic	MODS is used as a descriptive metadata structure inside METS metadata wrappers for storage or exchange of digital objects (Riley, 2010)

How standards can create issues. When creating metadata it is important to identify which metadata schema is most appropriate for the type of learning objects and metadata that are needed. If the appropriate schema is not used for the learning objects being added to a repository, then this will create problems with the learning objects not being found when searched (Gilliland, 2008). Each schema uses different terminology or descriptors to describe the learning objects being added. If the wrong schema is used, the learning objects could be described and indexed in such a way that they would not be found when searching using certain keywords. This can also be a problem, not with the schema choice, but with using data entered in alternative forms, such as excel, and then mapping that data into a schema (Beall, 2005; Hillmann, 2004). As pointed out by both Beall (2005) and Hillmann (2004), valuable information can be lost when the data are mapped into a metadata schema which results in disappointing information discovery or non-discovery of the learning object.

Why metadata are needed

Non-textual artifacts may be just as important as text-based artifacts as students nowadays have grown up in the computer age and have been called the post-literate generation (Kohl, 2010). Literacy is migrating from the exclusive domain of language into other areas of media including images (Kress, 2003). Teachers have been encouraged to "…make way for the powerful visual thinking lying dormant within our classrooms to surface in order to make sure our young people have the chance they deserve to pass the hurdles we put in their way" (Myatt, 2008, p. 189). Survey results indicate that 75% of faculty and 55% of students currently use non-textual resources in their teaching and research (Attig et al., 2004).

Although the use of visuals is an important instructional consideration as much learning involves visual imagery, the benefits for the students will depend upon the teacher's ability to find and use visual material effectively (Smaldino, Lowther, & Russell, 2008). Metadata are needed to accomplish this task. This is primarily true when one considers that "Much of our future searching may be visually-based rather than text term-based" (Kohl, 2010, p. 53). Again, metadata are needed to accomplish this task.

Relevant and appropriate metadata are also needed because, while users may have a preference to search for information visually, they are not adept at drawing out the correct information from the visual image (Brumberger, 2011). In a survey of 485 participants, respondents were not skilled at analyzing the factual information from the images such as where or when a photograph was taken. The survey found that participants were only able to correctly identify information about the image just under 50% of the time (Brumberger, 2011).

Metadata play an important role in determining accessibility, especially for non-textual learning objects as they create structure to a record where one did not exist before (Clyde, 2002; Maxymuk, 2005). If a non-textual learning object is properly described and indexed with metadata, the information that would be valuable and interesting to users would now be exposed and searchable (Daly & Ballantyne, 2009; Maxymuk, 2005). Most searches for educational resources are done using a typical search engine (i.e., Google) and this is effective for general purpose material; however, these search engines were not designed to find educational material and learning objects for non-textual material without metadata (Atkinson, Gonzalez, Munoz, & Astudillo, 2014).

Metadata are used to assist in the identification and retrieval of an object by including metadata elements that a user would use to search for learning objects (Greenberg, 2001). "The rise in interest in metadata is part of the effort to organize our rather messy world of digital resources and to provide access and services where none existed before" (Coyle, 2005, p. 160). Metadata are the textual surrogates that aid in the discovery and retrieval of the learning object, especially non-textual learning objects, as Seeman (2012) stated:

> Unless a visual object is happened upon by browsing, its efficient retrieval will be entirely dependent on the metadata accompanying it. In this way, it is separated from a textual object, which has at least the possibility of being discovered through its full text (p. 326).

While this review has narrowed the focus of learning objects to objects in a digital format, as stated in the learning object section, digital learning objects can exist as textual as well as non-textual objects. Both types of learning objects provide value for instructional and research purposes; however, as metadata are essential for the resource discovery of non-textual learning objects, this study will only focus on non-textual digital learning objects.

Harvesting of metadata

Metadata standards also serve a major benefit for non-textual digital learning objects as "Teaching, learning, and research today take place in a distributed networked environment. It can be challenging to find resources that are distributed across the world's libraries, archives, museums, and historical societies" (Cole, 2002, p. 76). One way to increase the chance of discovery is for institutions to develop systems that support interoperability. Interoperability is "the ability of multiple systems with different hardware and software platforms, data structures, and interfaces to exchange data with minimal loss of content and functionality" (National Information Standards Organization (U.S.), 2004, p. 2). Interoperability is a critical component of digital repositories in order for other servers to find and use the metadata created on a system (National Information Standards Organization (U.S.), 2004).

One way to increase interoperability is to use the harvesting protocol, Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), which exposes the collections' metadata to harvesters and then when users search for information, their metadata will be included in that search (“Open Archives Initiative Protocol for Metadata Harvesting,” n.d.). Metadata harvesting is “…designed to encourage metadata reuse and through metadata reuse data reuse and re-purposing” (Lynch, 2002, p. 136). A good example of this is Google, because when you do a Google search the majority of results returned are from data harvested from other systems. The Association of Research Libraries (ARL) survey by Ma (2009) found that 83 percent of respondents had adopted OAI-PMH. Conversely, the Research Libraries Group (RLG) survey showed that only 9 percent of the respondents stated that all of their non-MARC metadata was exposed for OAI-PMH, while 30 percent indicated that some of their non-MARC metadata was available for OAI-PMH(Smith-Yoshimura, Cellentani, OCLC, & Programs and Research Division, 2007).

Another issue related to resource discovery of metadata is the ability or inability of search engines to harvest metadata so that users who may not know about the repository can still find the learning objects. One problem that a harvester may have is the use of different schemas by repositories where the harvester must map all the different schemas to one common structure in order to make the data available for searching (Beall, 2005; Dunsire, 2008). This could result in tags being dropped or moved when mapped into the new schema which would decrease the likelihood of discovery for non-textual learning objects (Beall, 2005).

Who should create metadata?

The creators of metadata seem to fall into four different categories, with some institutions using more than one category. The most well-known category for metadata creation is that of information specialists, more commonly known as professional catalogers (Greenberg, 2000). The next category would be knowledge producers, which would be those that have an in-depth knowledge of the learning objects (Greenberg, 2002). Then there is a relatively new category called folksonomy in which multiple users tag objects with what they think is important information pertaining to the object (Gilliland, 2008; Gill, 2008; Goodin, 2007; Lytras & Sicilia, 2007). Lastly, there is computer-generated metadata in which a computer creates the metadata from the text of the scanned documents. Ma (2009) found that information specialists (87 percent) created metadata, but that knowledge producers were also involved in metadata creation (62 percent) and computer generated metadata creation (1 percent) was rarely utilized. Her survey did not address metadata created by folksonomy.

Information Specialists. Information specialists are professional catalogers who have a very detailed knowledge of multiple cataloging rules and standards; however, they may not be familiar with the context and/or the content of the learning objects that they are cataloging, especially when it applies to non-textual learning objects (Hillmann, 2004). Historically, information specialists have been considered the experts for creating metadata since they have been formally trained to have the required knowledge and skills needed to catalog materials (Greenberg, 2000). For textual learning objects, this may be the case, but for non-textual learning objects, the metadata should be created from an intimate knowledge of the learning object which the information specialist may not possess. There is the perception that information specialists should be involved in the metadata cataloging since they "…make sophisticated interpretative metadata-related decisions and work with classification systems, complex schemes, and other standards" (Ma, 2006, p. 10). However, there are concerns for information specialists being the sole creators of metadata due to "…the explosive growth of Web-based collections, leading to concern about a looming metadata 'bottleneck'" (Crystal & Greenberg, 2005, p. 178). This coincides with Hillmann (2004), who stated that when it came to analyzing and describing digital learning objects, few information specialists had the experience required and would need to spend time researching the learning object and possibly consulting with experts which increased the time and cost for metadata creation.

Knowledge producer/knowledge expert. On the opposite side of the information specialist category are knowledge producers who may not be familiar with cataloging standards, but have an in-depth knowledge of the learning objects and possibly the type of users that will be searching for the learning objects. A knowledge producer is defined as "…the originator and documenter of knowledge, who records explicit knowledge or makes tacit knowledge explicit…" (Markus, 2001). A knowledge producer may or may not be the originator of the learning objects or considered an expert on the learning objects but has considerable knowledge of the subject area in order to accurately describe the learning objects. "The potential sources for metadata are diversifying, and harvesting metadata from end-users no longer seems a strange idea" (Foulonneau & Riley, 2008, p. 187). Having the knowledge producer create the metadata for the learning objects has the benefit that "Resource creators are intimate with their work, they want their work to be discovered and consulted, and they know their audience and can thus describe their resources appropriately" (Greenberg, 2002, p. n.p.). It is becoming more accepted that knowledge producers can enter appropriate metadata, which could improve the resource discovery process and this is particularly true where the knowledge producer:

> …has significant understanding of the rationale for the dataset and the uses to which it could be put, and for which there is little if any textual information from which an indexer could work" (National Information Standards Organization (U.S.), 2004, p. 10).

Folksonomy. Another type of metadata creator that is gaining popularity especially with social media is folksonomy. "A folksonomy is developed collaboratively within a specific user community when many people use a shared system to label Web content, such as Web pages or online images, with descriptive terms, or tags" (Gill, 2008, p. 15). Since the vocabulary often used by individuals is different than those used by information specialists, "…tagging systems could be of use both to solicit descriptions from end- users (which could supplement or in some cases replace subject analysis) and as a source of new vocabulary terms" (Foulonneau & Riley, 2008, p. 189). An example of how this is used can be seen by looking at the website Flickr, where users upload photographs and then add metadata or 'tags' to the photographs in order to promote resource discovery. In order for folksonomies to be effective for resource discovery, a ranking system should be applied in order to increase the verification of the metadata for the learning object (Gligorov, Hildebrand, van Ossenbruggen, Schreiber, & Aroyo, 2011). For example, if one resource is tagged with the word 'Picasso' then there is no real validity that the resource is indeed associated with Picasso; however, if a hundred users were to add the metadata tag of 'Picasso' then there is a higher degree of certainty that the learning object has relevance. Some examples of sites that have incorporated a folksonomy approach are the University of Pennsylvania, which uses social bookmarking for locating, organizing, and sharing online resources; the State Library of Victoria in Australia, which requests users to 'share what they know' about images in their collection; and the museum community which is studying how social tagging can help to describe and access cultural heritage collections (Foulonneau & Riley, 2008).

Computer generated. "Automatic metadata generation indicates a minimal amount of (or none) human intervention, and so is cost-efficient for metadata records creation" (Zeng, 2008, p. 8). This is more the case for textual learning objects as they can be scanned to retrieve the words in the text to be used as the metadata. Even though technology has advanced where metadata can be generated automatically there are concerns about the quality of the metadata

(Lytras & Sicilia, 2007). At this time, human generated metadata are still of higher quality than what can be produced automatically (Beall, 2005; Greenberg, 2005). The American Research Libraries (ARL) survey seemed to agree that automatic metadata creation has not reached a functional state yet since institutions reported that 99 percent of the metadata are created manually (Ma, 2009). This would especially be the case for non-textual learning objects.

Even though this literature review briefly discussed the four different creators of metadata, this study will only focus on metadata created by knowledge producers.

Issues with knowledge producers creating metadata

One can now see why metadata are needed for non-textual learning objects and how knowledge producers may be the ones most appropriate to create the metadata; however, there are still some limitations involved with the creation of metadata. This section of the literature review will discuss different complications found with knowledge producers creating metadata.

Creation of searchable terms. Since the goal of metadata are to promote resource discovery, the more detailed the information can be the greater the chance for users to find the learning object. However, this requires a larger investment in the metadata creation process and increases the difficulty of promoting consistency in creating the metadata fields (Ma, 2006). When there is not consistency in the metadata creation process, problems can occur. "Regardless of the source of the differences, *mapping is about meaning*. Anything that contributes to meaning in one context must be mapped into the new context or there will be loss of meaning" (Attig et al., 2004, p. 256). This is especially true when the knowledge producers of the non-textual learning object create the metadata, which may result in different words that have similar meaning. For example, one person may describe the sections of a musical score as a 'bridge' whereas another person may describe it as a 'transition.' This creates the potential problem of having the same learning object described in different ways, which decreases the likelihood that the learning object will be discovered, since there is not a consistency of terminology.

The quality of the metadata produced to describe the learning objects is also important. An example of this can be seen with the Higher Level Skills for Industry (HLSI) repository where at the beginning of the project the repository had a problem with nearly half (46%) of the metadata being of poor quality, as discussed in Currier et al. (2004), with problems ranging from spelling errors to incorrect subject headings, which made resource discovery difficult. For example, someone described internal combustion that is stored on a flash file as 'flash file' instead of the correct subject heading of 'internal combustion' (Currier et al., 2004).

Incorrect metadata. When the metadata are left to an individual person to determine what data should be added to each field, there is a potential for problems as seen by Dushay & Hillmann (2003) who found records with metadata created as <dc:description>unknown</dc:description> or <dc:description>no information available</dc:description>. Since these are descriptive tags the learning object would not be found by users unless they actually searched for the word(s) unknown or no information available.

Word ordering. On a similar note, punctuation and word ordering can also be the source of resource discovery problems (Dushay & Hillmann, 2003). Dunsire (2008) discussed how format issues can be a problem as each repository may have different guidelines for how to enter the metadata. For example, the Networked Digital Library of Theses and Dissertations (NDLTD) allows the entry of the author name as it appears on the title page, but UK Eprints, which also stores dissertations, requires the author name in the format of surname-commaforename (Dunsire, 2008). Similarly, Currier et al. (2004) discussed the inability to find resources when an author's last name is changed, for example, when an author gets married.

Absence of performance support tools

In order to facilitate knowledge sharing among university faculty, other universities and the community at large, there needs to be a more intuitive process to help faculty describe their research and/or instructional materials. Based on the literature review thus far, an understanding of why metadata are needed for learning objects is evident and the literature has confirmed that knowledge producers are both capable of producing, and the preferred creators of, metadata when it pertains to non-textual learning objects.

The literature review indicates that a gap exists between the knowledge producers' knowledge of specific non-textual learning objects and their possession of the cataloging skills required to produce the metadata needed to access those non-textual learning objects. This gap could possibly be addressed by a tool with specific features that would support knowledge producers as they generate metadata for non-textual learning objects.

Because using a controlled vocabulary is a means of creating quality metadata (Ma, 2006), a performance support tool should contain a feature that involves the use of a controlled vocabulary. Implementing the use of controlled vocabularies in the performance support tool should create consistency for terms, which will increase resource discovery and allow users to find other learning objects related to the information they are searching. Since metadata are created to fit the needs of the people that will be searching for the learning object, then using a controlled vocabulary will help with the metadata creation by having consistent terms. Ma's (2009) ARL survey showed that the Library of Congress Subject Headings (LCSH) (96 percent) and the Name Authority File (NAF) (88 percent) were used by most respondents. The RLG survey reported similar results; however, half of the respondents (N=9) indicated that they had also used one or more locally developed thesauri (Smith-Yoshimura et al., 2007). Both surveys (ARL and RLG) were based upon what controlled vocabularies used by information specialists for metadata creation. The surveys did not address what types of controlled vocabularies were available for knowledge producers to use when creating metadata. Since knowledge producers are unfamiliar with metadata standards, the use of controlled vocabularies becomes more crucial for knowledge producers in order to create consistent metadata terms that can be used for searching.

Although "Use of a standardized subject thesaurus or other controlled vocabulary, for example, can provide greater precision and recall in searching, and can enable future functionality, such as faceted subject browsing and dynamic searching of subject matter" (Cole, 2002, p. 61), there are additional features that could help with metadata entry. These features include the use of tooltip boxes, which could help knowledge producers in understanding the metadata fields (Crystal & Greenberg, 2005) and the use of validation rules, so that fields that are needed for resource discovery cannot be left blank (Dushay & Hillmann, 2003). Another feature involves having an image of the non-textual learning object on the same screen as the form for entering metadata, since another study about using metadata entry forms found that "…the most time-consuming interface problem was switching between different contexts-such as the web application and another browser window" as this "…evidently challenged users' short-term memory…" (Crystal, 2003, p. 1039).

Although this literature review identified features that should facilitate the creation of high quality, easily accessible, descriptive metadata, no existing performance support tools containing all of these features were located that could assist the faculty in describing their non-textual learning objects.

Knowledge Harvesting

Given a better understanding of the metadata used and who can create the metadata, the next step is to look at how to harvest the knowledge associated with the potential learning objects. Before discussing how to go about harvesting the knowledge from the knowledge producers for learning objects, a definition of what is meant by 'knowledge' is needed. According to Davenport and Prusak (1998), knowledge is "A fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information" (p. 5). This is different from 'information', which they define as "a message, usually in the form of a document or an audible or visual communication" (p. 3) or 'data', which are "a set of discrete, objective facts about events" (p. 2). The key difference is that knowledge is something that exists within the mind of an individual, and is available to others through a process of codification (Davenport & Prusak, 1998). Codification "…literally turns knowledge into a code (though not necessarily a computer code) to make it as organized, explicit, portable, and easy to understand as possible" (Davenport & Prusak, 1998, p. 68). This can happen through conversation, storytelling, or other ways that consciously document what is known by the individual. Even though knowledge, information, and data are different, they are also interrelated because "…you can't have knowledge without information or information without data; so unless you get your data right, you're unlikely to be able to handle the other two" (Sturdy, 2001, p. 35).

Knowledge Management

There needs to be a way to manage the harvested knowledge so that it can be retrieved and reused by others, because if knowledge is not stored in a way that it can be retrieved by others, then it is useless (Schacht & Maedche, 2016). Knowledge management is the process where information is turned into knowledge and made available in a usable form to others (Angus, Patel, & Harty, 1998). "Knowledge management solutions have proven to be most successful in the capture, storage, and subsequent dissemination of knowledge…" (Dalkir, 2011, p. 3). Of course, knowledge management is not automatic and neither is it always successful. An excellent example of the loss of knowledge can be illustrated with the steam engine. As Schacht and Maedche (2016) explain, most people do not know that the steam engine was actually invented in the first century, where the power of steam was used to open the large-sized, heavy gates of the temples automatically, as this knowledge was lost during the Dark Ages. It was a long time before the power of steam was rediscovered and then another number of years until James Watt realized the potential of the steam engine which heralded the start of the industrial era (Schacht & Maedche, 2016). "One can hardly imagine where our society would be today, if the knowledge of the steam engine had been preserved in that time" (Schacht & Maedche, 2016, p. 20).

Dalkir (2011) states that we have now entered a stage of knowledge management, one dedicated to content management, which attempts to better describe and organize the content using metadata. By better organizing the content, then individuals are better able to find relevant knowledge and make use of it in their daily practice (Dalkir, 2011).

Since higher education institutions are involved with knowledge creation, dissemination, and learning they are therefore considered to be in the knowledge business (Ahmad, Lodhi, Zaman, & Naseem, 2015). A university's strategic approach to knowledge management can lead to the advancement of their knowledge sharing, as collaboration in research is the basis for new knowledge (Tan, 2015). "Universities and higher education institutions share a common vision-discovering, developing, preserving, and disseminating knowledge" (Ahmed-Kristensen & Vianello, 2015, p. 5), all of which are supported by the generation and use of quality metadata.

By collaborating via knowledge sharing, "…the research universities are able to support their academic staff in sharing their knowledge, thus helping them in the research work by allowing them to create new theories and ideas and establish new research principles" (Tan, 2015, p. 2). However, some faculty have resisted knowledge sharing, most likely due to the perception that it is a hassle to use the technology required and as a consequence, knowledge management systems used to collect, store, and distribute knowledge at research universities have become an obstacle which has deterred and prevented collaborative research among faculty members (Tan, 2015). Access to an appropriate performance support tool could lessen the resistance to sharing knowledge while increasing the opportunities. Of course, such a tool must exist before it can be used. Creation of such a tool is one of the goals of this study.

Summary

As more learning objects are either created as digital objects or modified to a digital format and then made available for use by others on the internet, there is a need for detailed metadata. Providing accessibility is a major role of metadata and this role is best addressed by descriptive metadata, as they are used to aid in the discovery of relevant information (Haynes, 2004; Hudgins, Agnew, & Brown, 1999; National Information Standards Organization (U.S.), 2004). Also, non-textual learning objects need descriptive metadata in order for these digital learning objects to be found by others to (re)use and share as this creates the potential to use the non-textual learning objects for many different purposes.

An effective way to get descriptive metadata is by having knowledge producers generate the metadata since they are familiar with the non-textual learning objects. "Metadata is used for the description of codified knowledge"; thus, it "needs to be well-organised, maintained and stored so that it can be retrieved, accessed and reused where appropriate" (Apostolou, O'Brien, & Ragsdell, 2007, p. 66). However, "Since resource authors generally lack experience creating metadata, they will be likely to need support to help them create effective metadata" (Crystal & Greenberg, 2005, p. 187). One possible way to do this is by having information specialists help the knowledge producers to generate the metadata; yet, this adds time and cost for creating each record. There currently is a gap in the literature that fails to address adequately the question of whether a performance support tool can assist the knowledge producers to efficiently create metadata for non-textual learning objects. As Crystal and Greenberg (2005) pointed out, "Succinctly explaining the fields of a standardized schema such as Dublin Core to metadata novices appears to be a key challenge for designers," (p. 185) and "developing a conceptual understanding of metadata records and their use in retrieval was found to be challenging for users" (p. 177). This study sought to fill the gap in the literature by designing and developing a performance support tool that allowed non-metadata experts to generate metadata for their non-textual learning objects while not requiring an extensive conceptual understanding of the metadata rules and schemas.

Even though the literature review briefly discussed five different types of metadata and four different creators of metadata, this study focused on only descriptive metadata created by knowledge producers. The next chapter details the methodology for the design and development of a performance support tool for non-textual learning objects by non-metadata experts.

Chapter 3: Methodology

This chapter describes the methodology of this study. It begins by reiterating the purpose of the study and the research questions. This is followed by the details of the methodology, starting with a discussion of developmental research, which is then followed by a description of the research design used for this study. Chapter 3 continues with the research and development (R&D) model used in this study, followed by a detailed description of the phases used to create a viable performance support tool for non-textual learning objects.

Purpose of the Study

The purpose of this study was to design and develop a performance support tool for knowledge producers to create metadata for non-textual learning objects. For the purpose of this study, knowledge producers are considered to be users that have knowledge, though not necessarily an expert, of the non-textual learning objects, and may or may not be the originator of the learning object. A performance support tool was designed and developed to assist knowledge producers in the creation of descriptive metadata for non-textual learning objects. The expectation was for the tool to help improve searching and thus increase the chance of discovery for the non-textual learning objects by instructors and/or faculty for use in their research and/or teaching material.

Research Questions

The following questions guided the study:

1. What characteristics and/or features would contribute to the design and development of a performance support tool to allow knowledge producers to create metadata for non-textual learning objects?

2. How might the characteristics and/or features of a tool be operationalized to allow knowledge producers to create metadata for non-textual learning objects?
3. What lessons will be learned from the design and development of a performance support tool?

Study Design

Development research is "the systematic study of design, development and evaluation processes with the aim of establishing an empirical basis for the creation of instructional and non-instructional products and tools and new or enhanced models that govern their development" (Richey & Klein, 2007, p. 1). Richey and Klein (2007) describe two types of design and development research: product & tool research and model research. This study fell into the product and tool research category, as this study focused on the design and development of a specific tool and the lessons learned from the tool development. The emphasis of this study was to describe and analyze the design and development process for a prototype of a performance support tool that could be operationalized by knowledge producers to create metadata for non-textual learning objects. The outcome of this study was the lessons learned through the process, which included context specific modifications identified through the evaluation of the tool, as well as the overall experience of designing and developing the prototype.

Research Model

"Research and development is an industry-based development model in which the findings of research are used to design new products and procedures, which then are systematically field-tested, evaluated, and refined…" (Gall, Gall, & Borg, 2007, p. 589). Like Gall, Gall and Borg (2007) who used the design model by Dick, Carey, and Carey as their research and development model, this study also used the design model by Dick, Carey, and

Carey (the ADDIE model), but one that had been adapted by Cennamo and Kalk (2005) as the research and development model. Using this model, the researcher iteratively developed a performance support tool for use by knowledge producers based on the features suggested in relevant literature and then revised the tool based on feedback gathered from the knowledge producers and owner through formative evaluation. After the first phase of testing, the tool was revised based on the analysis of the data received from the formative evaluation process. The information in Figure 1 graphically represents the Cennamo and Kalk (2005) model used for this study.

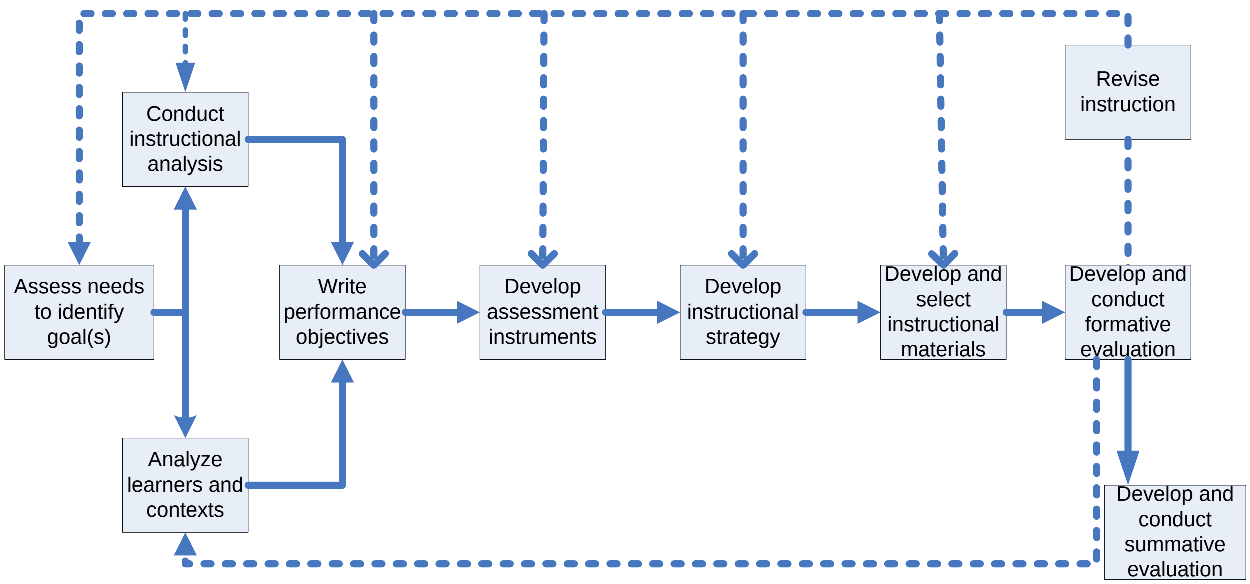

Figure 1. Model from Cennamo and Kalk (2005).

The researcher planned for the steps to follow one another in a sequential manner (as denoted with the solid line in Figure 1); however, the possibility existed based upon owner and/or pilot testing that a return to the previous steps may have been required, as represented by the dotted lines. The last step, develop and conduct summative evaluation, was not included in this study due to time limitations.

Setting and Participants

This study was conducted at a large research university in Southwest Virginia, with an enrollment of over 30,000 students.

The participants for this study included the following groups: the owner or subject matter expert (SME) and knowledge producers. In broader terms, an owner using the tool should be a person, who not only possesses the non-textual learning objects but also has detailed knowledge about the type of metadata that needs to be collected from the knowledge producers in order to generate the descriptive metadata for the objects, and may or may not be the originator of the object. The owner may or may not be the SME for the creation of the descriptive elements used to collect the metadata. Knowledge producers using the tool should have knowledge of, but are not necessarily considered experts regarding, the non-textual learning objects and may or may not be the originator of the learning object. The knowledge producer can range from the actual owner of the learning object to people that have contextual knowledge of the learning objects but are not the subject matter experts of the object.

In this study, the owner was a professor in the College of Agriculture with over 15 years of teaching experience. The participants were all students, two undergraduate and two graduate, majoring in the Agricultural field who had knowledge of the specific learning objects.

Procedure

Design and development of an instructional tool often involves multiple phases or steps. Four phases were implemented for this study. Phase 1 involved using a systematic review of the literature to determine the need for a performance support tool as well as potential characteristics for the tool. Phase 1 also consisted of the design of a prototype based upon those identified characteristics. Phase 2 consisted of the development of the prototype based upon the results from Phase 1. Phase 3 consisted of the creation of the collection and associated metadata form requirements by the owner followed by a pilot test using the tool and the metadata form created by the owner to generate metadata. Phase 4 consisted of a field test.

Phase 1 equated to a needs assessment to identify goal(s), analyze learners and contexts, conduct instructional analysis, and write performance objectives from the Cennamo and Kalk (2005) model. Phase 2 equated to the development of assessment instruments, an instructional strategy, and instructional materials from the Cennamo and Kalk (2005) model. During Phase 3, revisions to the tool were made based upon feedback from the owner and pilot testing, which equated to develop and conduct formative evaluation from the Cennamo and Kalk (2005) model. This phase of testing helped to ensure that the features in the tool assisted with generating the descriptive metadata for non-textual learning objects for a particular collection. After revisions from phase 3 were completed to the tool, phase 4 began, which consisted of a field test. Any revisions based upon the feedback received from the field test group are not within the scope of this study, but are available for future development of the tool. In all, there were two rounds of user testing (pilot and field), which is equivalent to develop and conduct formative evaluation from the Cennamo and Kalk (2005) model.

Design of Phase 1

Since the fundamental requirements for a performance support tool of this type were not clear due to the fact that a similar system was not available at the time of this study, Phase 1 of the study involved a systematic review of the literature meant to address research question #1. A literature review can and often does serve as the method for designing an initial prototype in tool design and development research, especially for exploratory studies (Richey & Klein, 2007). In this study, the literature served to reveal not only a need for a performance support tool to assist with metadata creation from knowledge producers, but also provided certain features that helped to improve the instructional component of the tool to assist with metadata creation by the knowledge producers. Four features identified in the literature were used in the design and development of a prototype performance support tool. A fifth feature, support for special characters, came from common coding standards and not from the literature review. Table 2 provides a summary of these features.

Table 2
Features for a performance support tool

New Feature	Reference(s)	Issues with commonly used methods
Controlled vocabulary (where applicable)	Ma (2009) Cole (2002) Dushay & Hillmann (2003)	Users are able to enter whatever term they feel is appropriate
Tooltips	Crystal & Greenburg (2005)	There is no additional help for users to understand the metadata tag and what data is needed.
Validation rules	Dushay & Hillmann (2003) Metadata Schema rules	Users are able to leave fields blank that are required for the metadata schema
Image on same page as metadata form	Crystal (2003)	Users have a id number or filename that identifies the object but may not be attached to the form where data is entered
Support for special characters	Generally accepted coding practices	Any special characters (for example ê) are stripped out of excel when extracted for xml.

The goal was that these new features would help to alleviate the problems that can and do exist with metadata collection. Examples of the potential problems knowledge producers may experience when entering metadata are seen in Figure 2 with metadata created via a spreadsheet.

A	B	C	D	E	F
file_name	<dc:creator>	<dc:date>	<dc:description>	<dc:title>	<dcterms:conservation>
AE_Archives_box02_env002_image01		1960-03-11	Blacksburg W-III Station, snow scene, R5 - Rain gage	Project 10 Image - VA Montgomery - 1960-03-11	Erosion_Control
AE_Archives_box02_env004_image01	Unknown	10/1/1960	Mountain Run Flood Control Res. Oct. 1960	Project 10 Image - VA Culpeper - 1960-10-01	Erosion_Control_
AE_Archives_box02_env004_image02	Unknown	Oct. 1, 1960	hybrid, a cross of A. rubrum Ã A. saccharinum.	Acer Ãfreemanii	Trees

Figure 2. An example of metadata creation.

When the knowledge producers enter data, there is the chance that discovery will be decreased when different knowledge producers enter different terms that should be the same or incorrect terms to describe the objects, which is illustrated in purple in Figure 2. The performance support tool implemented controlled vocabularies to minimize this issue. Next, the use of tooltips assisted the knowledge producers with what metadata was needed for each element and correct formatting for particular elements, such as the correct date format. This can be a problem when multiple knowledge producers enter dates in different formats for the same element (seen in blue in Figure 2). In addition, having validation rules where knowledge producers must enter data that is required by the metadata schema or owner will eliminate the problem seen in orange in Figure 2. Additionally, it is common for knowledge producers to have only an id number or file name listed on the data entry form (seen in yellow in Figure 2) and then they must find the learning object that corresponds to the id or file name to view the image separately from the metadata form. This not only increases cognitive load for the user (Crystal, 2003), but also increases the chance to have the incorrect metadata entered for the learning object. The tool addressed this issue by having the image of the learning object on the same screen as the metadata form so that the knowledge producer could view the image while entering the metadata. Lastly, when users enter metadata with special characters (as seen in green in Figure 2), some data may be lost when extracted from certain data entry programs, such as

Microsoft Excel. For instance, the correct entry in Figure 2 should be Acer Ãfreemanii; however, when it is extracted from Excel, it becomes Acer Afreemanii or Acer freemanii. This was corrected by storing all the metadata entered into a MySQL (My Structured Query Language) database which supports full Unicode characters; therefore, the data is displayed and extracted using the correct character set so the information will remain the same as what was entered.

Based on the literature review and summarized in Table 2, several new features were implemented so that the performance support tool assisted the knowledge producers in generating descriptive metadata for each non-textual learning object. As the tool is iteratively tested with various groups, more features may be added, but currently the features that were implemented for this study were: controlled vocabularies, tooltips, validation rules, support for special characters, and having the non-textual learning object on the same page as the metadata entry form.

Design of Phase 2

Phase 2 of the study involved the development of the performance support tool prototype. Development consisted of the establishment of a web site for the prototype. Within the website, I developed the tool functionality and user interface with HTML (Hypertext Markup Language), JavaScript, and PHP (Hypertext Preprocessor) to support the metadata entry for the learning objects. To support multiple character sets, I used MySQL (My Structured Query Language) as the relational database for storing the metadata and the JPG (Joint Photographic Experts Group) images.

I planned to provide in-person training for all of the participants. However, the owner was only able to work with the tool during the weekends and evening hours, so to accommodate his schedule, I created a training video for him to use to create the collection, metadata form, tooltips, and controlled vocabulary. The knowledge producers' schedule allowed time for in-person training on how to use the tool.

Prior to the start of the study, I also loaded 200 images representing different agricultural scenes from the 1930s and 1940s. These learning objects were provided by the owner and were part of a larger group of the owner's collection of learning objects that needed metadata. Fifty digital images selected from this assortment of the 200 learning objects were used in Phase 3 and the remaining 150 images were available for use in Phase 4.

Design of Phase 3

After the prototype development in Phase 2, pilot tests, involved one owner and two knowledge producers (one undergraduate and one graduate student), were conducted to verify the operation of the performance support tool's functionality. Given access to 50 digital images from Phase 2, the owner used the tool to create a collection, and then the metadata form, which contained all the elements, associated with the learning objects for the collection, along with an optional tooltip for each element. Once the collection and associated metadata form was created, then the owner created a controlled vocabulary for any of the elements he had created on the metadata form. Two knowledge producers then participated in a pilot test to create metadata using the tool with the form already generated by the owner for the 50 non-textual learning objects.

Design of Phase 4

After the pilot tests and revisions were made to the tool, field tests were conducted to test the revised tool and determine any additional revisions/additions needed. For this round of testing, participants had access to the remaining 150 unused, non-textual learning objects from the list of files the owner provided to use for testing the tool. The plan was to use the same metadata form that was used during phase 3 of the pilot testing; however, based upon feedback from the pilot test, four different collections with their own associated metadata form were created instead of only having the one collection that was used in the pilot test, for all of the learning objects. Two new knowledge producers that had not used the tool before (one undergraduate and one graduate student) along with one participant from the pilot test participated in the field test. The reasoning for this was to test how well the revisions performed for participants that were first-time users of the tool as well as to determine if the revisions helped the participant that had previously used the tool in the pilot test.

Data Collection and Analysis

As indicated by Richey and Klein (2007), design and development research often includes multiple sets of data collection and analysis for the different phases of a project. Three different data analysis components were used in this study. These included the design and development of the performance support tool, the exploration of the usability of the tool, and the lessons learned regarding the design and development process of the tool.

The first component, the design and development of the prototype of the performance support tool, required a literature review. Previous research on the characteristics needed to assist knowledge producers in creating metadata for non-textual digital learning objects was analyzed, especially for its relevance to knowledge producers that may not have a detailed understanding of metadata schemas to create the necessary metadata.

The second component to be analyzed was an exploratory study in which the owner (and/or SME) and knowledge producers evaluated the usability of the performance support tool. An exploratory study is useful when a tool is in the early stages of development, as this often involves exploring uncharted territories (Richey & Klein, 2007). The intent was to explore and describe how operational the tool was in a specific context.

The third component, the lessons learned regarding the design and development process of the performance support tool was an ongoing component throughout the research study. In design and development research, the researcher is expected to convey lessons learned that could potentially increase efficiency and effectiveness in future tool development projects (Richey & Klein, 2007). A descriptive analysis of the data collected was used to convey the entire design and development process and to give an interpretation of lessons learned through the process.

Pilot test collection and analysis

Instrumentation. Since this study needed to collect open feedback, I used an online survey as one instrument for the study rather than use an oral interview where the participants may be less forthcoming about their opinions on how well the tool worked for them. For the survey, I designed semi-structured open-ended questions to get an understanding of issues with the functionality of the tool and usefulness of the new features, as well as any additional features that would help participants to enter the metadata. The survey questions for the owner can be found in Appendix B and the survey questions for the knowledge producers can be found in Appendix C.

I used field observation notes as the second instrument for this study. The field observation notes consisted of title, location, date, time, participant name, and setting. The field observation notes also included a record of participants' behaviors while using the performance support tool and problems/difficulties found during observation.

Data collection procedures. After the approval of the Institutional Review Board (IRB), I sent emails to faculty (owners of non-textual learning objects) asking them if they would consider participating in the study (see Appendix D). After receiving confirmation that a faculty member agreed to participate, I emailed a consent form (see Appendix E). For details on the process the owner used for testing the tool, see Appendix A. I used field observation for all participants except the owner; because, the owner used the tool on weekends and as time permitted. He emailed me when any problems arose with using the tool. After the owner had completed his part in testing, two knowledge producers, who had a detailed understanding of the learning objects, were selected by the owner to test the tool. The owner sent the initial email to the two knowledge producers and then I arranged a meeting time/place with the two knowledge producers to provide in-person training on the tool. During this meeting, I gave the knowledge producers a consent form with details about the study (See Appendix F). After agreement from the knowledge producers that I could observe them using the tool, I used field observations to discover any difficulty/problems that the knowledge producers had while using the tool. One knowledge producer completed the metadata entry for all 25 items during the meeting, while the other knowledge producer completed the metadata entry for 15 of her 25 items during the meeting but came back later to complete the metadata entry for the remaining 10 items (which did not involve any field observation). For details on the process the knowledge producers used for testing the tool, see Appendix G. After the pilot test was completed, I sent an email to all three participants with the link to the survey to collect feedback about their experience using the tool (See Appendix B and C).

Test results. I used the data collected from the survey and the field observation during the pilot test to identify any difficulties the participants had using the tool and/or missing functionalities in the tool. The feedback from the pilot test surveys can be found in Appendix H.

Revisions. After the pilot test phase, the performance support tool was revised based on the results from the data analysis. The revisions included:

- Modify the Save button so it does not scroll off the screen
- Remove duplicate records
- Add the name of the file when items are uploaded
- Create multiple collections to simplify/clarify the data entry form
- Increase the number of items per page
- Make the image larger on the screen to make viewing easier

These revisions were completed before the next phase, field tests, began.

Field Test collection and analysis

Instrumentation. I used the same survey questions for the two new knowledge producers and one prior knowledge producer in this round of testing as were used in the pilot test (See Appendix C). I also used field observation for the two new knowledge producers to record any problems/difficulties found during the field test. For the knowledge producer that had previously used the tool, I did not employ any field observation, as she was already familiar with how to use the tool from the pilot test.

Data collection procedures. After the revisions were complete, the owner selected two new knowledge producers, who had a detailed understanding of the learning objects, to test the tool. The owner sent the initial email to the two new knowledge producers and to the two participants from the pilot test and then I arranged a meeting time/place with the two new knowledge producers. One participant from the pilot test was not able to participate but the other participant was able to test the tool again. During this meeting, I gave the two new participants a consent form with details about the study (See Appendix F). After agreement from the knowledge producers that I could observe them using the tool, I used field observation to discover any difficulty/problems that the knowledge producers had while using the tool. I asked both participants to enter metadata for at least 20 learning objects, which they both did during the field observation. One participant later completed the metadata entry for an additional 95 learning objects after the meeting was over on her own time. For details on the process the knowledge producers used for testing the tool, see Appendix G. After the field test was completed, I sent an email to all three participants with the link to the survey to collect feedback about their experience using the tool (See Appendix C).

Test results. I used the data collected from the survey and the field observations to identify any difficulties the participants had using the tool and/or missing functionalities in the tool. The feedback from the field test surveys can be found in Appendix I.

Revision. Even though no revisions were made to the performance support tool after this round of testing, the feedback from the surveys and field observation can be used to further refine the tool for additional testing.

Ethical Issues

Researchers' Role

Conflict of interest. As is typically the case with design and development research, the goal is to improve real world practice for researchers' having "…insights into the demands of the workplace, and having the foresight to envision new research that will facilitate disciplinary and professional progress" (Richey & Klein, 2007, p. 128). At the time of this study, I was involved in the development of a research repository where non-textual learning objects are a main component. From this position, I perceived a need for a tool to allow non-metadata experts to generate metadata as there was no similar tool currently available. The participants may also have been associated with the research repository. However, I was not in a position of power or influence over the participants and in no way could pressure the participants to participate in this study or complete the survey.

Performance support tool. The researcher is often the designer/developer in design and development research (Richey & Klein, 2007). As a result, the description and analysis of the design and development components are from the researchers' perspective. The performance support tool was designed using instructional strategies and characteristics discovered through the literature review. Using a formative evaluation for each phase of the testing aided in establishing credibility for the tool.

The goal in designing the tool was to construct a practical and effective way to create useful metadata for non-textual learning objects. Therefore, candid feedback from the participants was encouraged and their opinions were honestly reported. Participants were informed that critiques would be appreciated and they would help to enable future refinements and improvements to the tool.

Ethical Issues for the Study

This study underwent an institutional review board (IRB) approval through the institution where the dissertation research was conducted. All participants were given password-protected access to the website to create the collection(s), develop the metadata form and associated tooltips and controlled vocabularies, and generate the metadata for the learning objects, which was used to evaluate the effectiveness of the tool. The only personal information collected was the names of the participants and their usernames they used when logging into the performance support tool. This personal information was only accessible to the researcher and any identifying information was deleted from the data collection for this dissertation and omitted from any subsequent publications. Due to the small number of participants coming from a specific setting, only generalizations regarding the setting and the participants were described in the dissertation and any future publications.

Chapter 4: Findings

The purpose of this study was to design and develop a performance support tool for knowledge producers to create metadata for non-textual learning objects. Knowledge producers, for the purpose of this study, are users that have knowledge of the non-textual learning objects, but may or may not be the originator of the learning object. The study employed a tool development research design (Richey & Klein, 2007) which used a modified ADDIE process by Cennamo and Kalk (2005). The modified process consisted of analysis, design and development, pilot test, revisions, and field test as the research and development model. For the design and development of the tool, I implemented a prototype that consisted of revisions to the tool after the initial pilot test based upon feedback from the participants to improve the quality of the tool. Then a field test was conducted and feedback was collected but further revisions were beyond the scope of this study.

Feedback collected from the owner of the learning objects and the pilot test participants contributed to improving the quality of the performance support tool. Based upon feedback from participants, the tool was modified and improved. Following the modifications and improvements, a field test was performed. Feedback from the field test identified further refinements and improvements to the capabilities of the tool for future testing and eventual release of the tool for public use.

The previous chapter detailed the methodology for the design and development of the performance support tool. This chapter presents a summary of the findings related to the first research question, along with a more detailed explanation of the results from the pilot and field tests related to the second research question. The next chapter addresses the third research question.

Research Question One

The first research question was: What characteristics and/or features would contribute to the design and development of a performance support tool to allow knowledge producers to create metadata for non-textual learning objects?

Four characteristics emerged from a synthesis of the literature, with the fifth characteristic for character support following generally accepted coding standards. These characteristics are controlled vocabularies, tooltips, validation rules, having a relevant image on the same screen as the metadata form, and support for special characters. Controlled vocabularies help in metadata creation by creating a consistency in the expression of terms which leads to greater precision in searching to increase resource discovery (Cole, 2002; Dushay & Hillmann, 2003). The use of tooltips would provide additional information to help knowledge producers accurately describe the learning objects (Crystal & Greenberg, 2005) thereby providing assistance with the type of metadata to enter for certain elements/tags. Validation rules require that certain elements/tags contain descriptive metadata as leaving these elements/tags blank would decrease resource discovery by others (Dushay & Hillmann, 2003). Having a relevant image on the screen where the metadata are entered helps to decrease the cognitive load for the knowledge producers, as they do not have to switch between multiple screens to view appropriate images (Crystal, 2003). Lastly, support for special characters follows generally accepted coding practices where the data entered and stored should be the same data found when searching.

Research Question Two

The second research question was: How might the characteristics and/or features of a tool be operationalized to allow knowledge producers to create metadata for non-textual learning objects?

Operationalization of the characteristics identified in response to Research Question One required the design and development of a tool that ultimately would accommodate and support the operationalized form of the characteristics. The functional infrastructure of that tool is presented first in this section, followed by a description of the manner in which the operationalized characteristics are supported by the tool.

The underlying infrastructure of the tool designed and developed for use in this study was based on the use of collections. As used in this study, a collection contains an assortment of related learning objects. The relationships among the assorted learning objects provide common threads within the collection. The relationships among the learning objects for a particular collection are based on various factors, which are determined by the owner of the collection.

The tool was designed so that it could accommodate the creation and use of multiple collections. A single collection was used during the pilot testing phase and multiple collections were implemented for the field testing phase. To create a collection in the performance support tool, the owner clicked on the ‘Create a new Collection’ button (see Figure 3). Once the owner clicked the button, he was required to enter a name and, optionally, a description of the new collection (see Figure 4).

Figure 3. Creating a new collection.

Figure 4. Naming of a new collection.

Consistent with the notion that a collection contains an assortment of related learning objects, as shown in Figure 5, the owner is able to associate a specific learning object from an assortment of learning objects with a particular collection. The owner can determine which learning objects belong to a certain collection when the learning object is added to the tool or the knowledge producers can connect the learning object to a collection, especially if there are multiple collections, when they enter the metadata.

Figure 5. Learning object and collection.

Another feature of the tool's infrastructure is that each collection also contains a metadata form and this metadata form houses a number of elements (also known as a tag or field). The metadata form and its elements create organization within the collection while the metadata entries associated with the elements in the form establish meaning; without the metadata, you just have a site with a group of images with no relevant meaning. The owner may create as many elements as desired to get all the information needed to describe the related learning objects. To create an element, the owner would first select 'Add Element' and select the radio button for either Existing or New (see Figure 6).

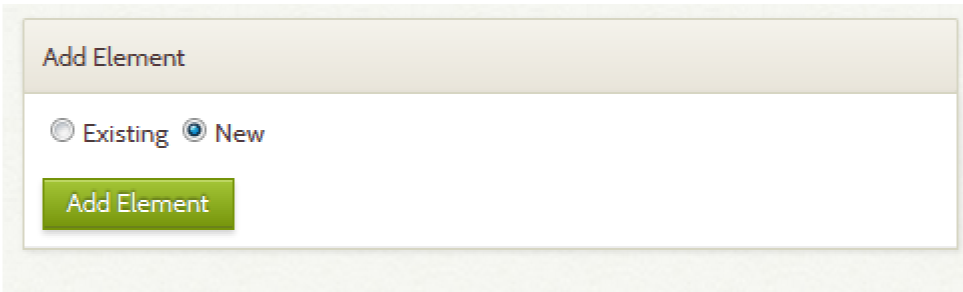

Figure 6. Adding a new element.

If the Existing radio button is selected, then the tool presents the owner with a pull-down box with a list of all the elements that currently exist in the tool (see Figure 7).

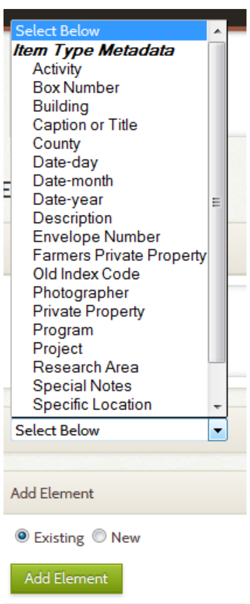

Figure 7. Adding an existing element.

If a desired element does not already exist in the tool, the owner would select the New option and then would be presented with a box where a new element can be created, as seen in Figure 8. The owner must give the element a name and an optional tooltip. The use of tooltips is discussed later in this chapter. An example of an element created after clicking the New radio button can be seen in Figure 9.

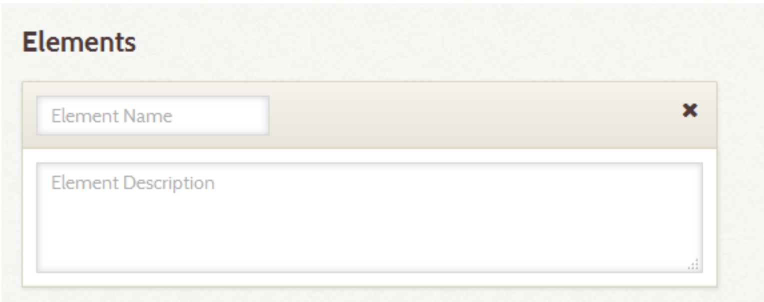

Figure 8. Creating a new element.

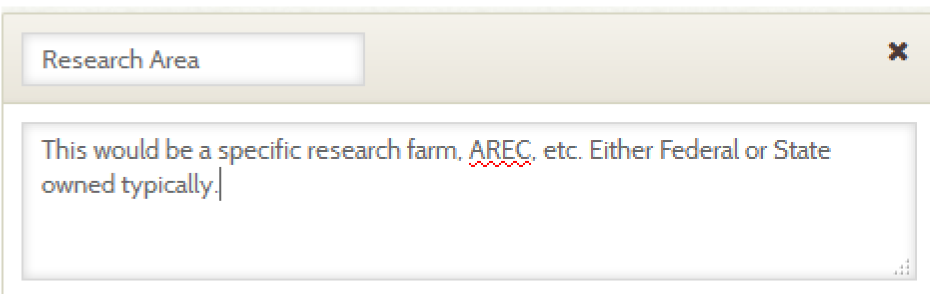

Figure 9. Newly created element.

After all new elements are added to the list of existing elements, the combination of these elements act as prompts within the metadata form and the knowledge producers will select or enter appropriate responses for each of the prompts presented in the metadata form (see Figure 10).

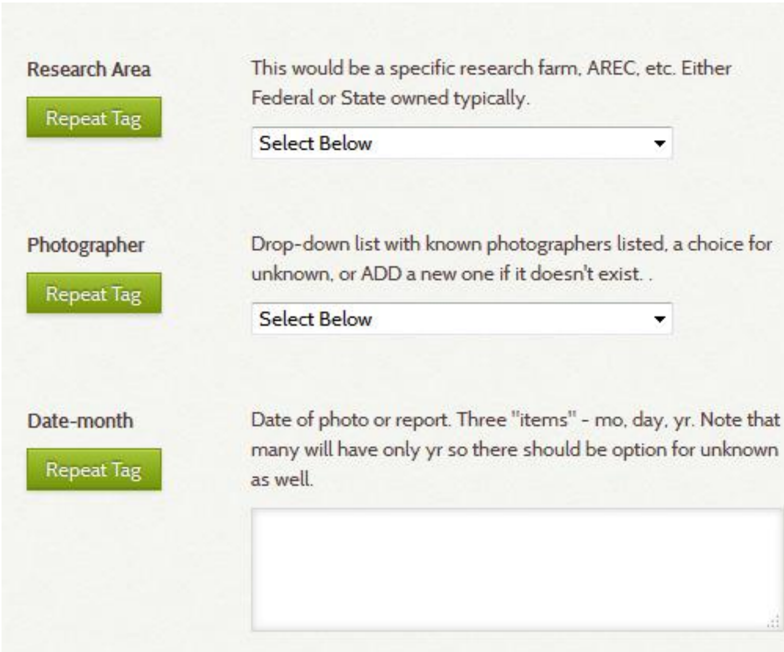

Figure 10. Completed metadata form with multiple elements.

Even though the participants using the tool may make suggestions as to any additional elements they believe should exist on the form, currently only the owner is allowed to create new elements that generate the completed metadata form.

The infrastructure was designed to allow the elements to contain a tooltip, which is a suggestion for the type of metadata that should be entered for this particular element (discussed in detail later in the chapter). Even though tooltips are helpful for the knowledge producers, especially if an element name does not make it obvious what the owner is looking for, they are not required.

The infrastructure was also designed to allow an element to have one or more vocabulary terms associated with the element. As will be discussed in detail later in the chapter, a controlled vocabulary is a list of predefined vocabulary terms that are preselected by the owner for use with a particular element. A controlled vocabulary list could contain only one term, e.g., if the element was Copyright and the owner wanted all the knowledge producers to choose the same copyright statement, or a list of terms, e.g., if the element was State and the owner created a list of all fifty states. The owner can create a controlled vocabulary list for any element on the metadata form, even though a controlled vocabulary list is not required for an element. Although the owner sets up the initial vocabulary list for an element, if an additional term is discovered during metadata entry, the knowledge producer has the ability to add additional terms to the vocabulary list.

The infrastructure was designed to permit all this information (collection, learning object, elements, and controlled vocabulary) to work together to produce the metadata that are used to describe the learning object that is then used for resource discovery. The remainder of this section includes a discussion of the means by which each characteristic from the literature review was addressed by the performance support tool.

The first characteristic based upon the literature review was implementing controlled vocabularies so that the knowledge producers would use the same words and formats consistently. To accomplish this, the owner of the learning objects created the metadata form and populated the form with relevant elements. Next, for any of the elements created on the metadata form, the owner then created a controlled vocabulary. By clicking the ‘Simple Vocab’ tab (see Figure 11), the owner was presented with the ’Simple Vocab’ page (see Figure 12).

Figure 11. Simple vocab button.

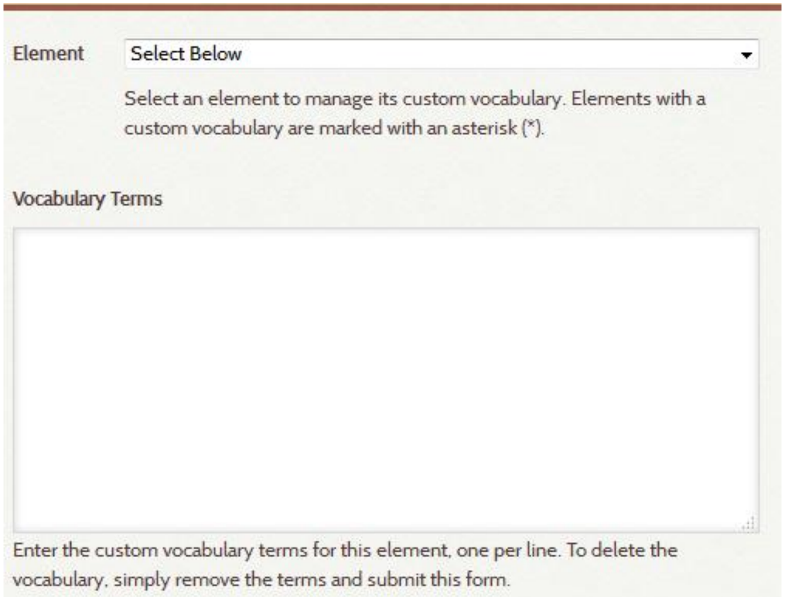

Figure 12. Simple vocab initial page.

The owner could choose any element from a drop-down list of all the elements that exist in the tool (see Figure 13).

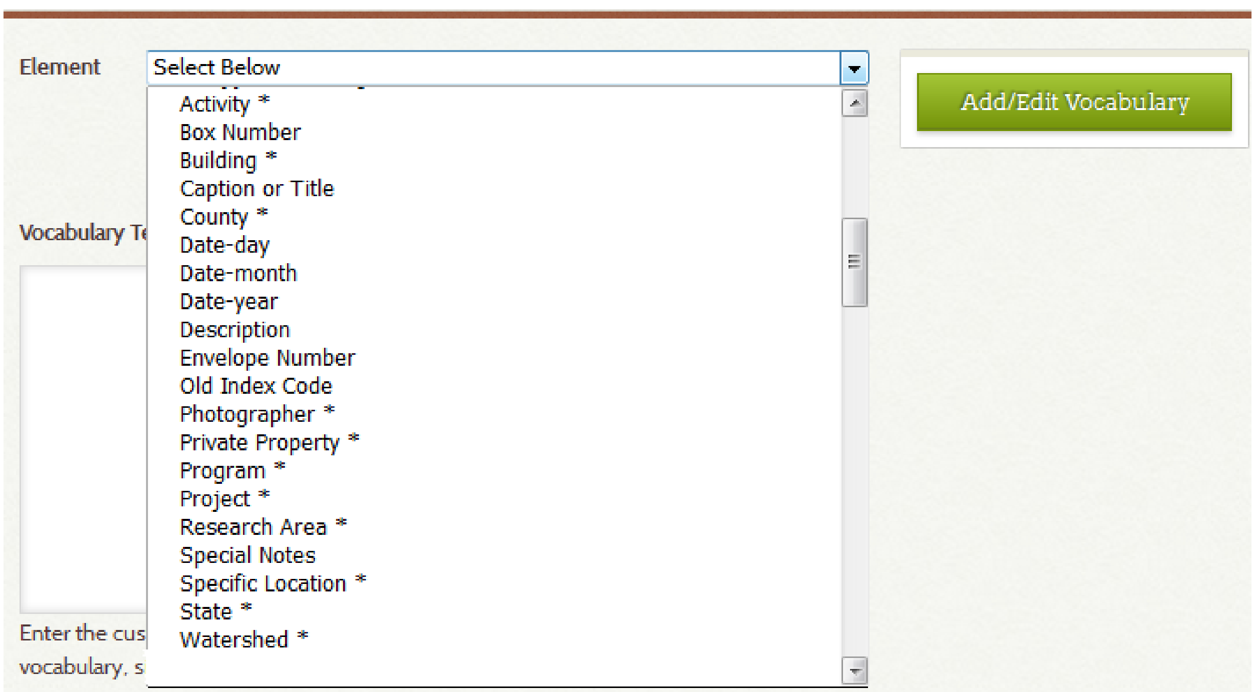

Figure 13. Controlled vocabulary list.

The owner selected an element for which he wanted to create a controlled vocabulary list and added as many terms as desired for the element in the Vocabulary Terms section, one term per line (see Figure 14).

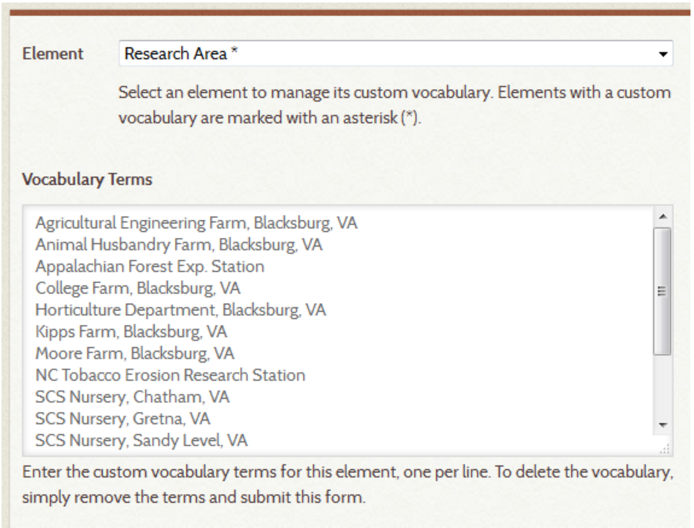

Figure 14. Completed vocabulary list.

When the knowledge producer entered the metadata for the Research Area element (which is the geographic area associated with the learning object), they were presented with a pull-down list, (in the preferred format determined by the owner) to choose from instead of typing the name of the research area in a format they preferred, as seen in Figure 15.

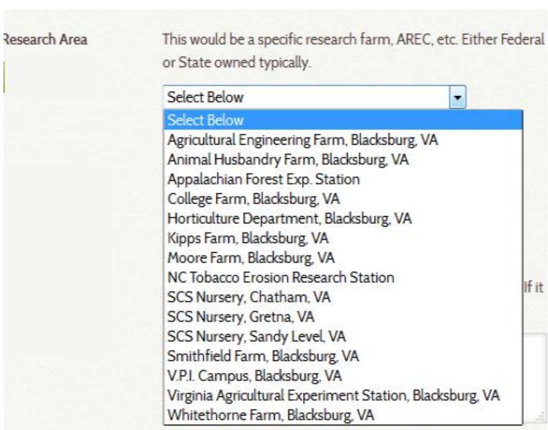

Figure 15. Pull-down list for a controlled vocabulary.

The controlled vocabulary is also useful if you have only one data element but you want all the knowledge producers to enter identical information for that element to maintain consistency. This would be useful for elements, such as Copyright or Publisher, if the metadata are the same for all tags and would be cumbersome for the knowledge producers to type for every learning object or where precise wording is important. An example of how this was implemented for this collection was the Source element, as seen in Figure 16. The owner wanted every learning object for the collection to have the project name AE Project10.

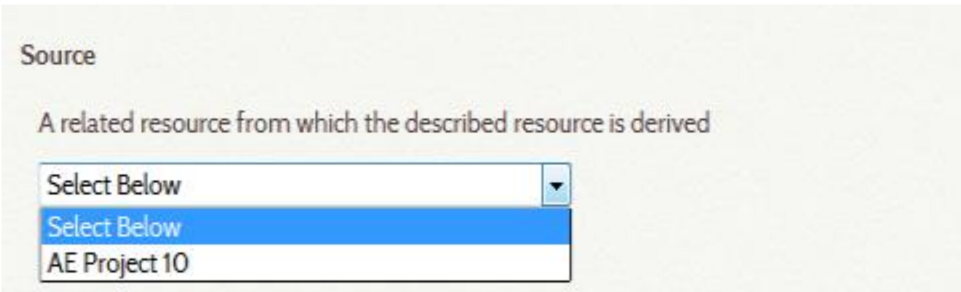

Figure 16. Controlled vocabulary with only one option.

The next characteristic found from the literature was tooltips, which were used to further assist knowledge producers with metadata entry. I implemented the tooltip feature by allowing the owner to create a tooltip when a new element was created on the metadata form (see Figure 17).

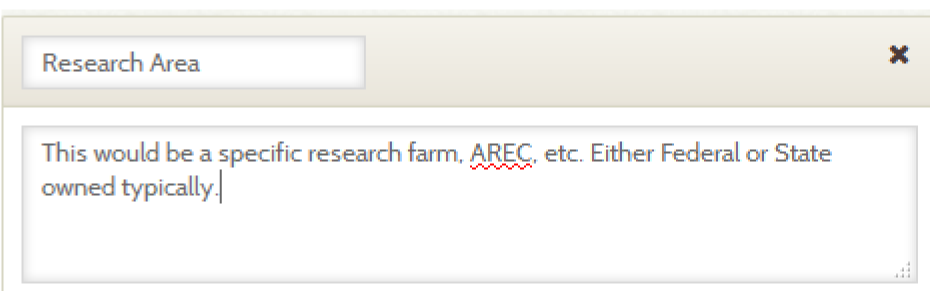

Figure 17. Creation of a tooltip for an element.

After the tooltip has been created for an element, the knowledge producers will see the tooltip beside the element name. The purpose of the tooltip is to help the knowledge producers know what type of data the owner is looking for in this particular element, as seen in Figure 18.

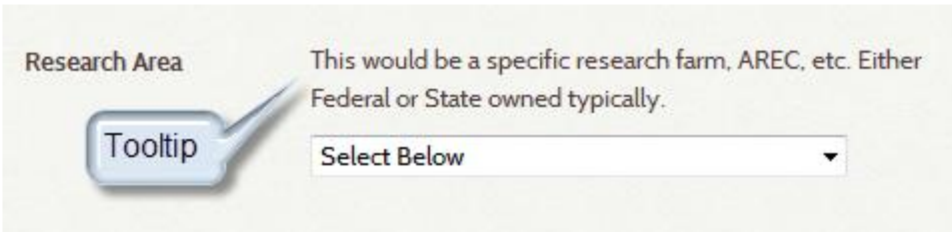

Figure 18. Tooltip on metadata entry form.

The next characteristic from the literature review is about validation rules. A common validation rule would require the knowledge producer to enter metadata for the elements that the owner deems necessary in order to describe the learning object. For example, filename or title could be required elements. The tool allows the owner to decide which, if any, elements are required to have metadata entered before the record will save. For this collection, there was only one validation rule required by the owner. If the element is required then an * appears beside the name of the element and at the top of the form it has '* required field'. If the knowledge producer does not enter metadata for a required field then an error message appears (see Figure 19) when they try to save the record.

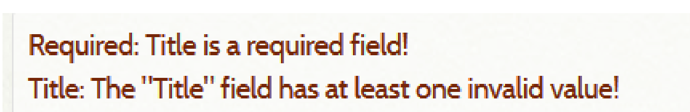

Figure 19. Saving a record without completing the required fields.

The next characteristic from the literature review is the ability to enter special characters as part of the metadata and not lose any of this information when the data is opened for public access or extracted for loading into another system. For example, if an element contained è as part of the word such as père then it should be displayed exactly as it was entered. When searching, the system can map the è to e, but it should still display in the metadata as père, not pere or pre. None of the data entered by the knowledge producers had special characters but in my testing of the prototype this worked as expected. The data are stored in a MySQL database, which is Unicode enabled; therefore, the data entered are stored in that appropriate character set and displayed/extracted as they were entered using the same character set.

Lastly, the research presented in the literature review found that having the learning object on the same screen as the metadata entry form reduced the cognitive load of the knowledge producer (Crystal, 2003). This also provided a method to verify visually the knowledge producer was entering metadata for the correct learning object. I accomplished this by displaying a thumbnail image of the learning object on the metadata form (see Figure 20) with the option to click on the thumbnail and display a larger image.

Figure 20. Metadata entry form with thumbnail image.

After deciding what infrastructure and processes were needed to operationalize the five characteristics from the literature review, I designed and developed the performance support tool based on a modified ADDIE process using a pilot and field test, with revisions after the pilot testing. As a result of this process, the test participants contributed to improving the quality of the tool by providing feedback on the tool, which I incorporated into the prototype following the pilot test. The means employed to capture participant feedback are discussed next.

For analyzing data collected from participants, I examined the data from the surveys and field observations and tried to find common or similar themes from the reviewers. Since the number of participants was small, this study did not use statistical analysis techniques, but instead focused on finding meaningful issues/problems regarding the effectiveness of the tool. Prior to the start of the study, 200 objects were uploaded for use in testing the tool. For the pilot test, two knowledge producers each created metadata for 25 different non-textual learning objects for a total of 50 learning objects that now have metadata. This left 150 learning objects without metadata. After revisions, one pilot test participant and two new knowledge producers created metadata for an additional 135 of the 150 non-textual learning objects for the field test. This left 15 learning objects without metadata.

Pilot Test – Owner

The survey from the owner during the pilot test resulted in a few modifications. During the pilot testing, the owner created one collection and added all of the tags/elements to that one collection for the knowledge producers to create the metadata. A response from the survey was that the owner would prefer that when the knowledge producers selected a specific element, the metadata form would be populated with only those elements identified by the owner as being related to that selected element. Specifically, when the element 'Specific Location' which had a drop-down list consisting of: Building on Campus, Research Farm, Private Property or Watershed, (as seen in Figure 21), was selected, additional elements would appear on the form based upon the location selected.

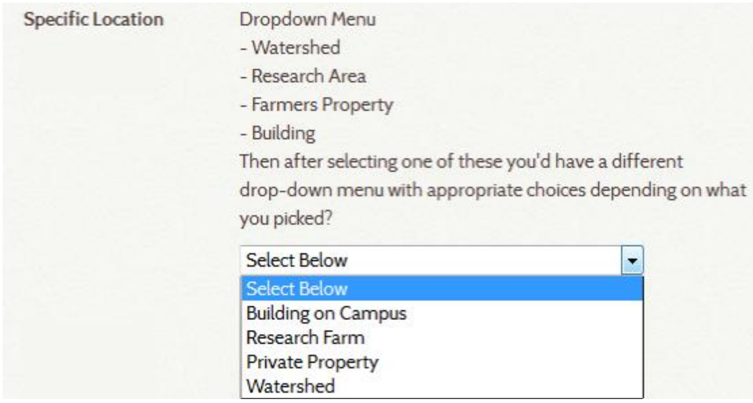

Figure 21. Specific Location Element for Pilot test.

This was addressed before the field test, by instead of having only one collection named AE_Project10, as was the case during the pilot testing phase, there were four separate collections (Building, Research Area, Farmers Property and Watershed) for the field test. In agreement with the owner, I created the four separate collections. For the field test, when the knowledge producers first edited a learning object, they chose from a list of four different collections (Building, Research Area, Farmers Property, or Watershed) which corresponds to the specific location element, from the pilot test (see Figure 22). The form was then populated based upon the tags relevant for the particular location. This achieved the change suggested by the owner that certain elements appear on the form based upon the selection of the specific location for the particular learning object. Each learning object corresponded on only one collection; none of the learning objects spanned multiple collections.

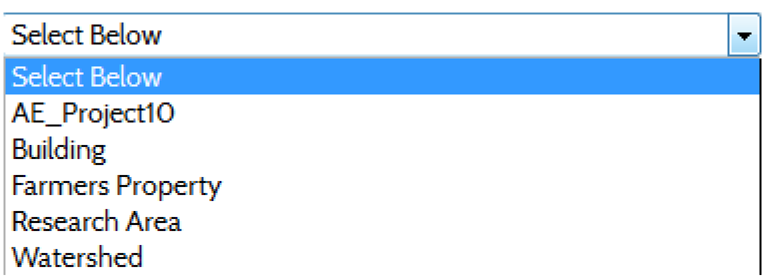

Figure 22. Specific location selected before form is generated for field test.

Each collection contained some elements that were the same amongst all four collections, e.g., all four collections contained the elements: Box Number, Photographer, Date, State, and County. Along with the elements that span across all four collections, each collection also contained some elements that were specific to that type of collection. For example, the collection Farmers Property contained all the common elements listed above but it also contained an element for Private Property, which was associated with a vocabulary list with the name of the landowner’s property. Figure 23 shows a completed Private Property element.

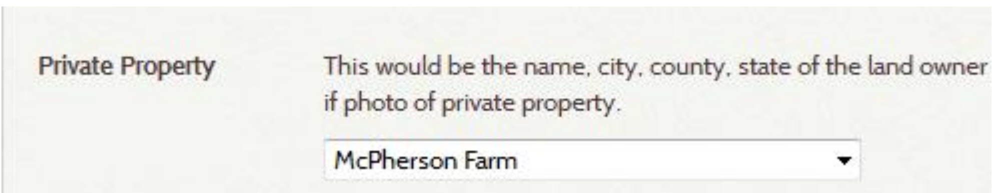

Figure 23. Element for farmers property collection.

If, instead, the collection was Research Area, then the collection would contain the elements common to all the collections plus an additional element for the Research Area (see Figure 24). It would not contain the Private Property element used only for the Farmers Property collection.

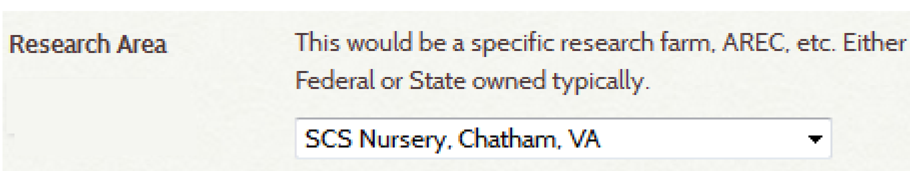

Figure 24. Element for research area collection.

With this approach, the only elements listed on the form are those that are relevant to the learning object, which should make it less confusing for the knowledge producers as to which elements need metadata.

The survey questions for the owner of the non-textual learning objects are presented in Appendix B. A summary of the survey results from the owner during the pilot test along with the revisions made can be found in Appendix H.

Pilot Test – Knowledge Producers

The surveys from the two knowledge producers during the pilot test also resulted in additional modifications. After creating metadata for 50 learning objects, the two participants completed an online survey about their experience using the performance support tool.

The survey results indicated that both participants had an issue with returning to page one after adding the metadata. Once the knowledge producer saved the changes, a summary screen of the metadata for that record was displayed with a note that the record was successfully changed. On the right hand side there was an option to edit again or go to the previous or next item (see Figure 25). However, from the field observation during the pilot test, the knowledge producers would normally click on the left hand sidebar on the 'Items' tab which initiated a new search, instead of using the previous or next item buttons.

Figure 25. Screen after saving a record.

Even after noticing the previous or next item button, several times they would still click 'Items' which initiated a new search. I revised the software to display more items on the page (50 per page vs. 10) to see if this would help when they clicked 'Items' instead of Previous/Next. Since the 'Items' tab is used for an initial search, it would not be easy for the program to know when the Item tab is clicked for an initial search or when it should return the user to their previous search location. I wanted to see if by having the majority of the learning objects all on one page would help during the field test; however, the results from the field test were the same as during the pilot test. The knowledge producers still had a tendency to click on the 'Items' tab instead of using the Previous/Next button.

Many of the changes suggested by the knowledge producers revolved around the form having elements that did not apply to their learning object. This resulted in a metadata form with too many elements and the knowledge producers not knowing if they needed to enter metadata for the extra elements or if the tag/element did not apply for this particular object if it should be left blank. This made it more difficult for the knowledge producer as they did not know if the element should be left blank or if they were expected to enter some type of metadata for that field. If they did enter metadata for the elements that were not applicable for the particular learning object, this would result in incorrect data. By breaking the form into multiple collections (see Figure 22 above), instead of one collection with all the elements on the same form (see Figure 21 above), this should make the form easier to complete by only having the relevant elements that are related to the particular learning object. For the field test, the knowledge producer first determines the specific location (Building, Research Area, Farmers Property, or Watershed) then the form appears with only the relevant elements based upon the location so there are no extraneous elements for the knowledge producer to figure out what/if data is needed.

One participant suggested that the learning object be larger on the metadata entry form. When the knowledge producers edited a learning object, two images were displayed: a small image was displayed at the top of the form and a thumbnail image was displayed along the right-hand side. The thumbnail image moved down the screen as the user entered the metadata so that the image is always viewable to the knowledge producer as seen in Figure 26. The knowledge producer could click on either image to view a larger image but this larger image opened in another tab or window, thus requiring them to move between windows to view the image.

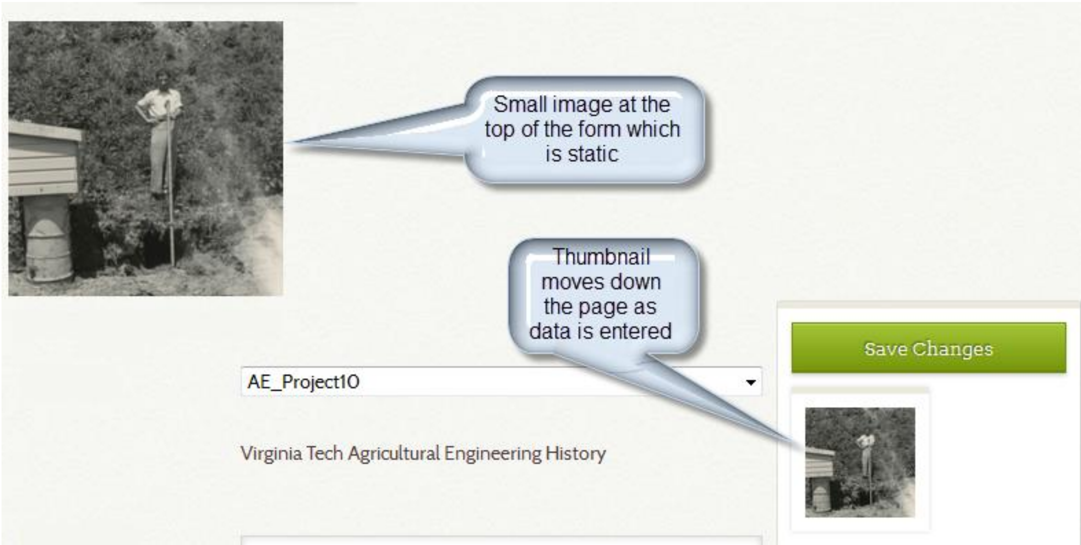

Figure 26. Image on metadata form.

Based on the comments, I modified the thumbnail to be a larger image for the knowledge producers to view but kept the thumbnail on the right hand side the same, see Figure 27.

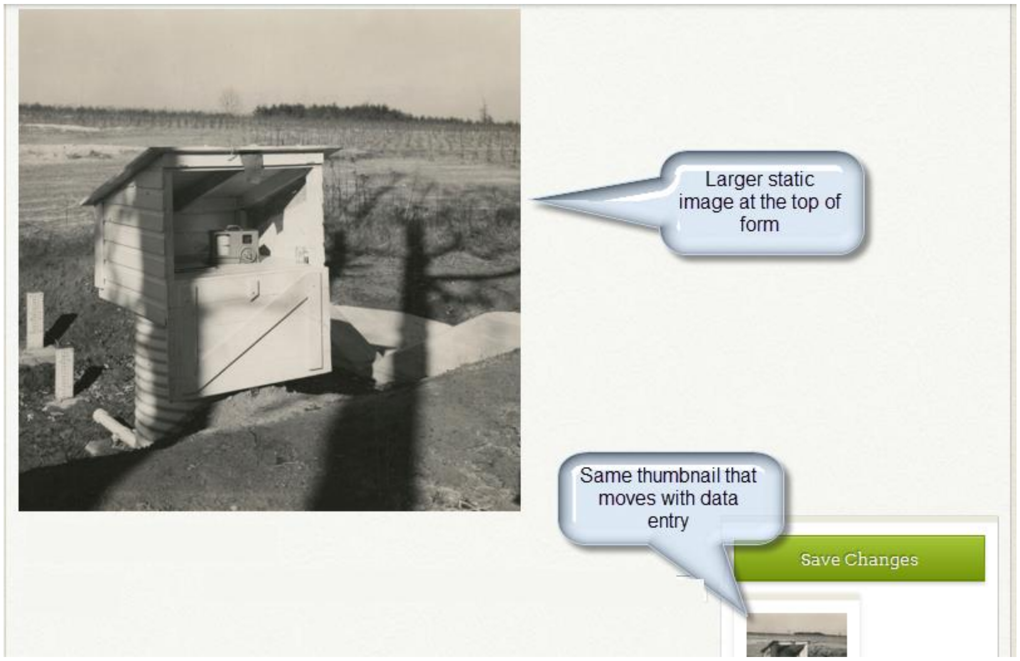

Figure 27. Revised image on metadata entry form.

The survey questions are presented in Appendix C. A summary of the survey results from the knowledge producers during the pilot test phase along with the revisions can be found in Appendix I.

Field Test

Once all the revisions from the pilot test were completed, the field test began. For the field test, one knowledge producer from the pilot test re-tested the revised tool so she could compare the changes to the original design in the pilot test phase and two new knowledge producers tested the tool for the first time to see how the revisions worked for users that had no previous experience with the tool. From the remaining 150 learning objects of the initial 200 loaded prior to the start of the study, metadata were created for a total of 135 learning objects, leaving only 15 learning objects without metadata. All three participants completed the same survey used in the pilot test (see Appendix C for the survey questions). I provided in-person training to the two new users. For the user that already had the initial training during the pilot test, I did not provide any additional training as I wanted to examine that user's reactions to the new changes based upon the knowledge producers' familiarity from using the tool during the pilot test.

The survey results following the field test provided additional suggestions that could be applied to the performance support tool. The field observation during the field test did not produce any additional modifications, except for the same frustration observed during the pilot test where the knowledge producer would click on the 'Items' tab to initiate a new search and have to find the last record they modified. As one participant suggested, creating the ability to hover the mouse over the thumbnail to generate a larger view could be a helpful way to view the image. Another new feature could be an 'Add' button where knowledge producers would have the ability to add new elements that did not exist, yet felt are needed or useful for the learning object. Lastly, a participant suggested there be a link/duplicate button for images that are the same so the knowledge producer does not have to enter all the information again.

A summary of the survey results from the knowledge producers during the field test can be found in Appendix J.

Chapter 5: Discussion of Lessons Learned and Conclusions

The performance support tool was developed to support knowledge producers as they create relevant and appropriate, descriptive metadata for non-textual digital learning objects. These metadata promote the (re)usability of information that otherwise might not be found and may be lost to others without such descriptive metadata. In developing the tool, the study employed a tool development research design (Richey & Klein, 2007). I learned several lesson from the research process and results from the study. In this chapter, I discuss the lessons learned and conclusions about additional testing and the practical use of the tool.

Lessons Learned

I used findings from the literature review to identify both the requirements of the performance support tool and suggestions as to why these requirements would be helpful to generate metadata for digital non-textual learning objects. The findings from the literature review also suggested strategies that would be important for owners and knowledge producers that may not have an understanding of metadata standards. I implemented those strategies for the pilot test, made modifications based upon feedback from the pilot test, and then re-tested the tool again.

Learning to use the tool

During the course of the study, I learned the importance of flexibility when creating and delivering lessons related to how the participants used the tool and the overall design of the tool. Initially I had planned to conduct in-person training in the use of the tool for each participant. However, due to the owner’s schedule, he was only available to work with the tool on the weekends and in the evening hours. To overcome the unpredictability of the owner’s availability, I instead created a training video on how to use the tool, including how to create the collection and add elements, tooltips, and controlled vocabulary terms for the collection. The owner was able to create the collection, add the elements, create tooltips, and enter controlled vocabulary terms by watching the video, as seen in Figure 28.

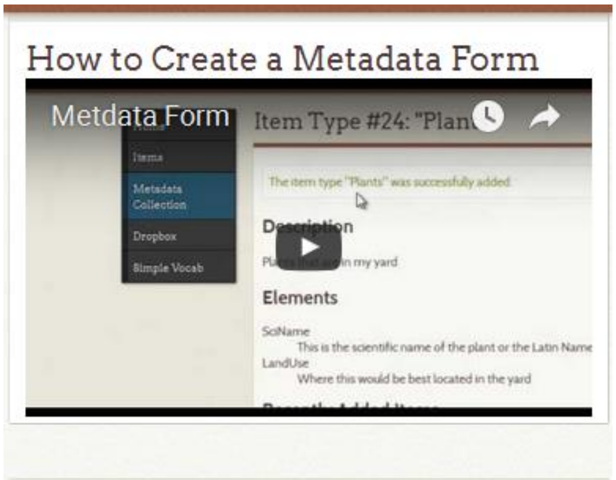

Figure 28. Training video.

Since the knowledge producers had more predictable schedules and were available for training, I conducted in-person training for the pilot test participants and then again for the new participants for the field test.

Providing training by two different methods revealed the flexibility and scalability of the tool for use with different users as in-person training can be used but is not required in order for users to understand how to use the tool. Both groups stated that the tool was easy to use. The owner, who watched the video, created the collection/metadata form/tooltips/controlled vocabulary that the knowledge producers used without assistance. The knowledge producers created the metadata for the learning objects from the in-person training.

Creation of the collection/metadata form

The participants using this tool did not have a detailed understanding of the different metadata standards for the learning objects they encountered. These standards often require very specific metadata in order to generate descriptive metadata that would allow the highest level of granularity for the best opportunities for learning object (re)use by others (Kim, 2009). I believed that flexibility in the creation of a metadata form was an appropriate strategy to overcome these deficiencies. This flexibility encouraged the owner to create a metadata form with his own element names and tooltips. Because the knowledge producers could relate to the owner's element names and tooltips, it seemed likely they would generate more descriptive metadata than using a metadata schema with predefined elements/tags that may not make sense for the particular collection or to the knowledge producers.

This approach did seem to help the knowledge producers by making it easier to generate the metadata but the results also indicated that more forethought about how the form should flow from one element to another would have been helpful. It seems that what made sense for the order that the owner used to describe the learning objects did not always apply to the knowledge producers.

During the pilot test, all elements were contained in a single collection and their information appeared on one metadata form. The survey results from the owner stated that he would like the metadata form to be populated with additional elements based on the selection of the 'Specific Location' element. Similarly, the survey results from the knowledge producers stated that it would be nice if the elements that did not apply to a selected learning object were not included on the form as it was confusing whether to put information in that element or not. With these recommendations in mind, I suggested to the owner that for the field tests, four metadata collections (Building, Research Area, Farmers Property and Watershed) be created. When the knowledge producers decided which one of the four collections was appropriate for the learning object, then the metadata form was generated based upon their selection (See Figure 22 above). The owner agreed that this would be a good change.

I implemented this change for the field test, with mixed results. The two new participants did not have a problem with this design but the participant that had used the tool in the previous test preferred having one collection with all the elements on the metadata form. This is different from what I expected, as the results from the pilot test indicated that the users got overwhelmed with all the elements and were not sure which ones needed metadata and which ones could be left blank. However, when there were less choices to make, the user that had tested both ways preferred having all the elements available to choose from.

Learning Objects

Creating metadata. A surprising finding from the study was the knowledge producers had some difficulty with navigation through the learning objects. Although I did not anticipate this problem, evidently changes are needed to the way users navigate through the learning objects. Even though, after saving a record, there was a 'Previous Item' and 'Next Item' button, the participants would consistently click on the 'Items' menu to initialize a new search, which frustrated them as they had to find where the last learning object they had modified was located. The modifications made for the field tests did not improve the results as the knowledge producers still had a tendency to click on the 'Items' tab. It was helpful to observe the intuitive nature of the knowledge producers as to how they used the tool. As the tool progresses forward in testing, some ideas for modifications to correct this would be to have a 'Return to previous item' button appear on the menu list under the 'Items' tab once a user has initiated a search.

Another finding from the study was the desire on the part of the knowledge producers to have the power to create additional elements/tags on the metadata form. The knowledge producers felt that additional elements/tags were needed on the metadata form to describe the learning object. Currently, only the owner can create elements on the metadata form. If this feature were implemented, this would need to be an option that the owner could turn on or off as some owners would not want knowledge producers creating new elements. This feature has some definite benefits as it empowers the knowledge producers to expand the metadata with elements they determine as useful, but it also has some drawbacks as this new element may not apply to the other learning objects or the metadata could be entered into an already existing field.

An additional finding from the study was the suggestion to be able to link/combine duplicate learning objects that had to be recorded more than once. For this particular collection, there were some instances of duplicate learning objects, e.g., a photograph was taken twice or duplicated so the same image is in the tool twice. When uploading the images, each image had a different filename, e.g., box07_env131_image01 and box07_env131_image02, if these images happened to be duplicate photographs, both were uploaded as different learning objects. Linking or combining duplicated learning objects could be a useful feature for this particular collection as it did contain duplicate images, but this feature might not be applicable for other collections if the collection did not contain duplicate learning objects. A variation of this suggested feature that could be implemented whether the learning object is a duplicate or not, would be an auto-fill feature that brought up data that had already been added for that element as the knowledge producer starts to enter the metadata. The knowledge producer could select the appropriate data that matched the information for that element, which would eliminate having to retype the entire description again for the learning object.

Controlled Vocabulary. I considered the controlled vocabulary as a major feature for the tool as it creates a consistency for the naming format which helps with searching and grouping of similar items (Cole, 2002; Dushay & Hillmann, 2003; Ma, 2009). The owner found the use of the controlled vocabulary very helpful. I even observed the knowledge producers adding data to the list of controlled vocabulary terms for elements that did not have the term they needed. They did not seem to have any difficulty with adding a new term to an element that had a controlled vocabulary, which was an additional benefit that I had not anticipated.

The controlled vocabulary turned out to be a very useful part of the tool as it allowed the owner to add any terms to certain elements that he wanted the knowledge producers to use. The findings from the study concurred with Ma (2006) and Cole (2002) that by implementing a controlled vocabulary, one would create quality metadata by providing greater precision for searching. This not only helped the knowledge producers with the metadata but also created a consistency for the wording so that multiple learning objects contained the same data for the element since the wording was the same, which improves searching. The knowledge producers were still able to add additional terms to the vocabulary list if the correct term for their learning objects did not exist. This empowered the knowledge producers to create new metadata terms that not only described the learning object but also added to the list of controlled vocabulary terms that other knowledge producers could then use for their learning objects instead of only being able to use what the owner had created.

Tooltips. The use of tooltips is an essential feature to assist the knowledge producers with understanding what type of metadata was needed for a particular element (Crystal & Greenberg, 2005). The survey results indicated that all the participants agreed that the tooltips were very helpful to them, even though some felt the tooltip may have been a little too long for certain elements. Since the owner created the tooltips to explain what type of metadata was needed for a particular element, I did not believe the length of the tooltip description should be limited.

Image on same screen as metadata form. It was anticipated that having the learning object on the same page as the metadata form would decrease cognitive load (Crystal, 2003) so that the participants did not have to use one monitor to enter the metadata and another one to search through filenames to find the image of the learning object. The results of the study agrees with the literature as all the participants agreed that having the image of the learning object right beside the metadata form was helpful and was a good way to check that the data being entered was for the correct learning object. I did not anticipate that the participants would want a larger version of the image on the form but when I implemented this for the second round of testing, it was well received. In retrospect, the addition of a hover feature so that a larger image is displayed on the screen when the mouse moves over the thumbnail image would have been an excellent way to accomplish this and should be implemented before further testing.

Contributions to the IDT Field

By creating metadata for these learning objects, they then have the potential to be discovered and used by others. The learning objects could then be considered open educational resources (OER) for other instructors to use in their own research or instructional materials. Providing searchable metadata that accurately describes the learning object creates the ability for these digital assets to be used by others or to provide additional information to the public at large for diverse types of learning objects. Even though one never knows how others may use the information that can be found via the Internet, by creating the metadata for these objects they now have the chance to be found and used by instructors, researchers, or instructional designers when creating teaching material.

Conclusions

Although the pilot and field test participants as well as the owner had some valid suggestions for improving the usability of the tool, they all were able to use the tool's initial features. The tool helped the owner by creating and populating a customized metadata form that was consistent with the type of metadata needed for this particular collection. The tool also helped the knowledge producers during the pilot and field tests to create the necessary metadata for the non-textual learning objects which in turn created the ability for this collection and elements therein to be found and used by others in their teaching and/or research. Even without the modifications and additional improvements that could be implemented to the tool, the metadata created by the knowledge producers resulted in learning objects with their associated metadata that if the tool were opened for public access and users searching for this type of data would be able to find these learning objects. For example, someone interested in agricultural that wanted to know about flooding during the 1930s or gaging equipment would find these learning objects based upon the metadata created during the study.

As this was a prototype, more testing will need to be completed before the tool is ready for release to the public. Being that the tool was in the early stages of development, it was necessary to begin testing with a small number of participants from one academic department to understand how the tool works and what features should be added/modified/removed. With a couple of revisions already made, the tool is now ready for testing with a larger group of participants and with different types of collections to determine if the tool can handle a variety of different learning objects.

This collection only contained Agricultural learning objects. The tool needs further testing to determine how well it will work with different types of collections. This tool has the potential for use by diverse types of organizations. For example, it could be tested with historical collections by allowing different level of users (expert to novice) that are familiar with the learning objects to create the metadata. It could also be tested using a crowd sourcing or a folksonomy approach that could be used to collect metadata. This approach could be useful for museums as the tool could allow any public user to describe the learning object. The tool could accomplish this by allowing online public anonymous users to either fill out a brief metadata form or just enter one term that describes the learning object and then use an algorithm to determine the most likely results by ranking. There is also the potential for testing with genealogical researchers by uploading family photographs and then having several different family members (no matter where they are located) create metadata associated with the photographs. This testing by multiple types of organizations with different collections helps to broaden the scope of the tool.

Participants that are entering metadata for diverse types of learning objects may have a different experience or require additional features that were not required or discovered during this study. In addition, the learning objects came from a research university department and the knowledge producers were students within that department. The tool should be tested with different populations such as a historical society, genealogical society, museum, or public library, to determine if additional features and different terminologies are required.

The performance support tool was developed for a practical purpose – to support knowledge producers in creating metadata for non-textual learning objects using a non-standard metadata format. The process integrated into the tool was designed to help knowledge producers enter descriptive information that could then be searched by others as they attempted to find relevant learning objects to use for their own teaching and/or research. The multiple features and flexibility of this tool allow metadata to be created for different types of learning objects.

The participants acknowledged the tool was easy to use and made the process of entering metadata simpler. With further revisions and testing, the tool has the potential to allow many different types of collections to add descriptive metadata to their non-textual learning objects. These descriptive metadata could then be used by others to find and use these objects to supplement their own teaching and/or research material or to just further the knowledge of the public.

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Appendix A: Detailed use of the performance support tool by the owner

Once the owner agreed to participate in the study, I created a username with the appropriate permissions. The owner then received an email with the link to the performance support tool. When the owner clicked on the link, it took the owner to the login page asking the owner to create a password for the account, this way I would not know the password for any of the users. After the password was set, the owner could enter the website for the tool. The main page contained the video for how to use the tool (See Figure 28 above).

The first step for the owner was to create a collection or multiple collections. This was done by clicking on the 'Metadata Collection' tab and then 'Create a new Collection' button. The owner gave a name to the collection (required field) and then created as many (existing and/or new) elements as needed along with tooltips for each element (see Figure 8 and 9 above). The owner ended up creating twenty elements for the initial collection used for the pilot test phase, as seen in Figure 29).

Figure 29. List of elements created.

After creating the metadata form with associated tooltips, the next step was to create controlled vocabularies for any elements that exist in the tool. Once the owner clicked on the 'Simple Vocab' tab, he would be taken to the page where he created the vocabulary terms (See Figure 30).

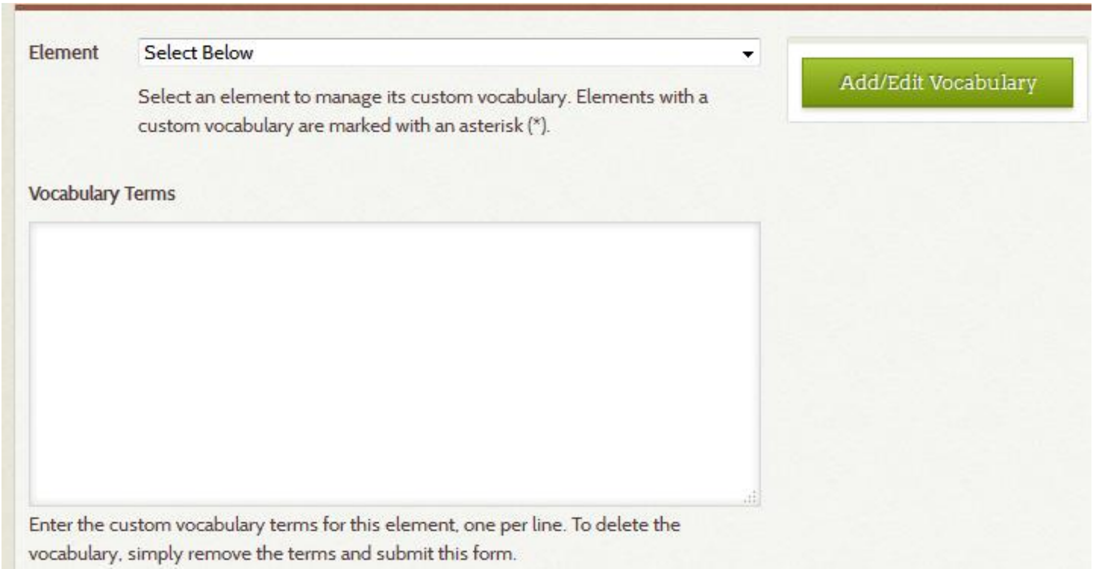

Figure 30. Simple vocab page.

Using the element list pull-down, the owner selected any of the elements that already existed in the tool and/or any elements that he created (see Figure 31).

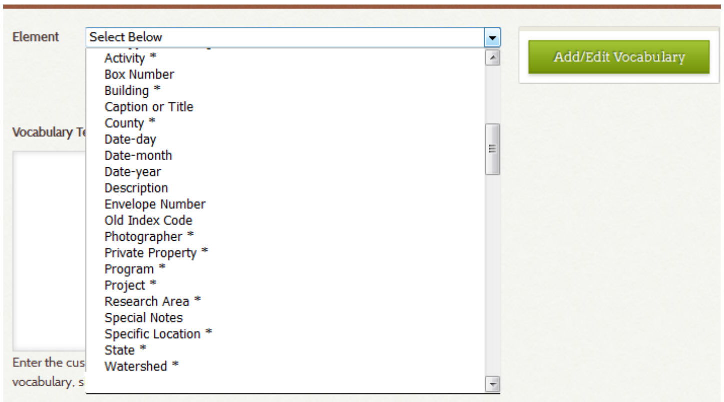

Figure 31. List of vocabulary elements.

If there is an asterisk (*) by the name then a vocabulary list has already been created, but that term can still be selected to add more entries, as the knowledge providers did when some entries did not currently exist in the list. Enter vocabulary terms, one per line, for example see Figure 14 above for a completed vocabulary list. The list can be as long as needed, for example if the element was State, a vocabulary list could be create for every state. There is also the option to have only one entry if the terminology entered by the knowledge producers should be the same for all learning objects, for example, Copyright, could have a pull-down list with the only option being: Property of this University, College of Agricultural.

Prior to the start of the study, I also loaded 200 images representing different agricultural scenes from the 1930s and 1940s. These learning objects were provided by the owner and were part of a larger group of the owner's collection of learning objects that needed metadata.

Appendix B: Survey Question for Owner

The following interview questions are for a dissertation study to develop a performance support tool for non-textual digital artifacts. This interview asks about your experience with the prototype of the metadata harvester. Your responses will be kept confidential and your honest feedback about the tool will help to improve it for future use. You also have the right to ask the researcher of this study to change or discard your responses. Thank you in advance for your participation.

Survey Questions:

1. Did you find the video helpful in understanding how to set up your collection? Was there any additional information that could have been added to the video to make setting up the collection easier?
2. Did you find any functional problems with you click on the ‘Metadata collection’ menu? If you did, what is the function that had a problem?
3. Did you find any functional problems with you click on the ‘Create a new Collection’ button? If you did, what is the function that had a problem?
4. Could the user interface be improved or corrected when you used the ‘Create a new Collection’ button to create your metadata tags? If yes, would you describe the user interface and your ideas to improve it?
5. Did you find any functional problems when you used the ‘Add Element’ button to create a new metadata tag? If you did, what is the function that had a problem?
6. Could the user interface be improved or corrected when you used the ‘Add Element’ button to create a new metadata tag? If yes, would you describe the user interface and your ideas to improve it?

7. Did you find any functional problems when you use the ‘Simple Vocab’ button to create your controlled vocabularies? If you did, what is the function that had a problem?
8. Could the user interface be improved or corrected when you used the ‘Simple Vocab’ button to create your controlled vocabularies? If yes, would you describe the user interface and your ideas to improve it?
9. What modifications would help to improve your ability to create a metadata form for the artifacts?
10. What final thoughts about the metadata harvester would you like to share?

Appendix C: Survey Questions for Knowledge Producers

The following interview questions are for a dissertation study to develop a performance support tool for non-textual digital artifacts. This interview asks about your experience with the prototype of the metadata harvester. Your responses will be kept confidential and your honest feedback about the tool will help to improve it for future use. You also have the right to ask the researcher of this study to change or discard your responses. Thank you in advance for your participation.

Survey questions:

1. Username (used when logging in to the tool):
2. Did you find any functional problems when you clicked on the 'Items' menu? If you did, what is the function that had a problem?
3. Could the user interface be improved or corrected for the 'Items' menu to see the items in the collection? If yes, would you describe the user interface and your ideas to improve it?
4. Did you find any functional problems when you used the 'Edit' items button to create the metadata? If you did, what is the function that had a problem?
5. Could the user interface be improved or corrected with the form to create the metadata? If yes, would you describe the user interface and your ideas to improve it?
6. Could the user interface be improved or corrected for the tooltips for each tag to assist with the type of metadata to enter for that tag? If yes, would you describe the user interface and your ideas to improve it?
7. Did you find any functional problems when you used the 'Repeat Tag' button to add another tag to enter additional metadata? If you did, what is the function that had a problem?

8. Could the user interface be improved or corrected for the ‘Repeat Tag’ button to add another tag to enter additional metadata? If yes, would you describe the user interface and your ideas to improve it?
9. Did you find it helpful to have the image on the same page as the metadata entry form? If no, would you describe your ideas to improve this feature?
10. What modifications to the current metadata entry form would help to improve your ability to create metadata for these artifacts?
11. What feature, not currently in the existing tool, would help to improve your ability to create metadata?
12. What final thoughts about the metadata harvester would you like to share?

Appendix D: Request to Participate Email for Owner(s)

Hello,

My name is Michelle Ervine and I am a PhD student in Instructional Design and Technology at Virginia Tech. I am writing to see if you could help me with my dissertation by participating in my study. My dissertation focus is on the design and development of a performance support tool to assist users with creating metadata for non-textual digital artifacts, such as photographs. If you have digital non-textual artifacts and would like to see if a web tool could help you to create metadata, then please consider participating in this study. This would give you the opportunity to have descriptive metadata created for your non-textual artifacts that could then be added to a repository. After completion of the metadata study phase, I can extract your data that you entered into an XML file that you could use to load into your repository so that you would not have to duplicate your work again.

Let me explain what would be involved by participating in this study. You would upload your artifacts (photographs) to the performance support web-based tool and create a metadata form and controlled vocabularies (after watching a short video tutorial on how to perform each of these steps) for any information that you would like generated for the particular set of artifacts. If you feel that the videos do not contain enough information, I would be available to meet with you one-on-one to help you get this all set up so that others would be ready to enter the metadata.

Once the form is ready and the artifacts are uploaded (between 20-40 items), then you would have 1-2 users that you choose to create the metadata for the artifacts you uploaded. Then everyone would complete a survey about how effective the performance support tool was and any suggested improvements. Once the modifications to the tool have been made, there would be another round of testing where you would upload an additional 20-40 artifacts and the same 1-2 users plus an additional 1-2 users would create metadata for these new artifacts. This way the same user(s) that used the tool before plus new user(s) that have not seen the tool can test how well it works. Then all the users that created metadata would answer the survey again to determine any additional changes/improvements.

Would you be willing to participate in this study? If so, I will email you a consent form for you to sign and email (or mail) back to me. I would also need you to email the name and email address of the users that you would like to enter the metadata as I would need to setup an account for them in the tool so they could log in and also send them a consent form with information about the study. Please note that participants must be at least 18 years old to participate in this study.

If you would like to discuss this study with me in further detail to determine if your data would fit the requirements of this study or if you have any other questions about this study in general I would be glad to meet with you to discuss it further.

Appendix E: Consent Form for Owner

Informed Consent for Participants

<u>Title of Research</u>:
Development of a performance support tool for the curation of non-textual digital learning objects

<u>Principle Investigator</u>:
Michelle Ervine, doctoral student at Virginia Tech

Purpose

The purpose of this study is to design and develop an instructional tool for knowledge creators to use for the creation of metadata for non-textual learning objects. A metadata harvester prototype will be designed and developed to allow knowledge creators, who may not have an in-depth understanding of metadata schemas and cataloging rules, to enter metadata. Knowledge creators, for the purpose of this study, are considered to be users that have knowledge of the non-textual learning objects, but may or may not be the originator of the learning object. They will use the tool to create metadata for the learning objects which may then be imported into a knowledge repository which will contain a collection of learning objects to better facilitate searching and discovery of those objects and thus reuse by other instructors and/or researchers.

Procedure

You are expected to use the web-based form developed for this study as a pilot tester or field tester. After the using the tool, you are expected to answer the survey questions from the link provided in the email you will receive after agreeing to participate in the study. The survey questions will provide the data for this study.

Risks

There are minimal risks to participation in this study. Risks to you are no greater than the risks associated with the use of normal web-based applications. In addition, you have the right to withdraw from participation at any time by notifying the researcher in writing of your desire to withdraw.

Benefits

There are no direct benefits to you for participation in this study. No promise or guarantee of benefits has been made to encourage you to participate. Indirect benefits for the owner may include being able to input their data into a knowledge repository with metadata for the non-textual artifacts, so these materials are preserved for future use. The benefit to society could be instructors, researchers and the community at large would be able to find and use these artifacts for their own instructional/research purposes. Society may also benefit by using this tool to upload their non-textual materials for metadata creation for future use.

Extent of Anonymity and Confidentiality

The researcher will keep all data collected confident. Information gathered from the study, including the non-textual artifacts and metadata generated, may be used in the dissertation, presentations, patent registration, and articles for professional journals. However, your name will not be used in any dissertation, presentation, or journal articles and identifying information will be changed (pseudonyms will be used) so that data cannot be connected to a particular individual. Every effort will be made to ensure no identifying characteristics will be revealed in the reporting of the data.

Only the research and chairperson will have access to the identifying information contained in the raw data, while others will only see the pseudonym information. The raw data will be stored for two years after the completion of the study, after which it will be destroyed permanently.

Compensation

There will not be any compensation for participating in this study.

Freedom to Withdraw

You are free to withdraw from this study at any time without penalty. Please email me (ervinem@vt.edu) should you want to withdraw.

Permission

I voluntarily agree to participate in the research. I have the following responsibilities: to participate in two rounds of testing for the performance support tool as well as completing a survey for suggested improvements and/or difficulties using the tool. I also agree to allow the non-textual material uploaded, along with the metadata created to be used as examples in the dissertation and future journal publications.

I hereby acknowledge the above and give my voluntary consent for this study.

______________________________ _______________

Participant's Signature Date

Should I have any questions about this research or its conduct, I may contact:
Dr. Ken Potter Learning Sciences and Technology, School of Education
kpotter@vt.edu

Michelle Ervine Learning Sciences and Technology, School of Education
evinem@vt.edu
(540) 231-0621

If I have any questions about the protection of human research participants regarding this study, I may contact Dr. David Moore, Chair Virginia Tech Institutional Review Board for the Protection of Human Subjects, telephone: (540) 231-4991; email moored@vt.edu

Appendix F: Consent form and details about study for Knowledge Producers

Hello,

My name is Michelle Ervine and I am a PhD student in Instructional Design and Technology. My dissertation focus is on the design and development of a web-based tool to assist users with creating metadata for non-textual artifacts, such as photographs. Your name has been suggested as a potential participant for this study.

Let me explain what would be involved by participating in this study. Some non-textual artifacts, such as photographs, have been uploaded to the performance support tool. Your name was suggested due to the fact that you have knowledge about these non-textual artifacts and could help to create metadata for them. The artifacts have been uploaded and the metadata form has been created. You will use the tool to create the metadata associated with the artifacts, after watching a short video tutorial on how to perform each of these steps.

After you have created the metadata for the artifacts, you will complete an online survey about how well the tool worked to help with creating the metadata and any suggested improvements to the tool.

There will be two rounds of testing; you may participate in one or both rounds of testing. If the participants are associated with a university, please note: Participation in this study will have no impact on your grades in any classes you may have with the instructor. Your name was given as being able to create the metadata for the artifacts the instructor intends to use, but the instructor will not be notified of your decision whether to participate in the study or not. The instructor will also not have access to your survey answers. Your participation, metadata generated, and survey responses will all be kept confidential.

If you agree to participate in this study, please send me an email (ervinem@vt.edu) with a preferred username, so that I may set up an account in the tool for you. Also, please read the consent form below. Once you send me your preferred username, you will receive another email with the URL to the tool where you will set up a password and then can begin entering metadata. If you would like to discuss this study with me in further detail or if you have any other questions about this study in general I would be glad to discuss it further.

Informed Consent for Participants

Participants,

As required by the Institutional Review Board, this Informed Consent form will provide you with information about this study. **Your consent to participate in this study will be implied when you activate your account in the performance support tool.**

Title of Research:

Development of a performance support tool for the digital curation of non-textual artifacts

Principle Investigator:

Michelle Ervine, doctoral student at Virginia Tech

Purpose

The purpose of this study is to design and develop an instructional tool for knowledge creators to use for the creation of metadata for non-textual artifacts. A metadata harvester prototype will be designed and developed to allow knowledge creators to enter metadata. Knowledge creators, for the purpose of this study, are considered to be users that have knowledge of the non-textual artifacts, but may or may not be the originator of the artifact. They will use the tool to create metadata for the artifacts which may then be imported into a knowledge repository which will contain a collection of artifacts to better facilitate searching and discovery of those objects and thus reuse by others.

Procedure

You are expected to use the web-based form developed for this study as a pilot tester or field tester. After the using the tool, you are expected to answer the survey questions from the link provided in the email you will receive after agreeing to participate in the study. The survey questions will provide the data for this study.

Risks

There are minimal risks to participation in this study. Risks to you are no greater than the risks associated with the use of normal web-based applications. In addition, you have the right to withdraw from participation at any time by notifying the researcher in writing of your desire to withdraw.

Benefits

There are no direct benefits to you for participation in this study. No promise or guarantee of benefits has been made to encourage you to participate. Indirect benefits for the owner may include being able to input their data into a knowledge repository with metadata for the non-textual artifacts, so these materials are preserved for future use. The benefit to society could be instructors, researchers and the community at large would be able to find and use these artifacts for their own instructional/research purposes. Society may also benefit by using this tool to upload their nontextual materials for metadata creation for future use.

Extent of Anonymity and Confidentiality

The researcher will keep all data collected confident. Information gathered from the study, including the non-textual artifacts and metadata generated, may be used in the dissertation, presentations, patent registration, and articles for professional journals. However, your name will not be used in any dissertation, presentation, or journal articles and identifying information will be changed (pseudonyms will be used) so that data cannot be connected to a particular individual. Every effort will be made to ensure no identifying characteristics will be revealed in the reporting of the data. Only the research and chairperson will have access to the identifying information contained in the raw data, while others will only see the pseudonym information. The raw data will be stored for two years after the completion of the study, after which it will be destroyed permanently.

Compensation

There will not be any compensation for participating in this study.

Freedom to Withdraw

You are free to withdraw from this study at any time without penalty. Please email me (ervinem@vt.edu) should you want to withdraw.

Permission

I have read the Informed Consent and the conditions of this study. I have had all of my questions answered. I hereby acknowledge the above and give my voluntary consent when I log-in to the performance support tool.

Contact Information

Should I have any questions about this research or its conduct, I may contact:

Dr. Ken Potter Learning Sciences and Technology, School of Education
kpotter@vt.edu

Michelle Ervine Learning Sciences and Technology, School of Education
evinem@vt.edu
(540) 231-0621

If I have any questions about the protection of human research participants regarding this study, I may contact Dr. David Moore, Chair Virginia Tech Institutional Review Board for the Protection of Human Subjects, telephone: (540) 231-4991; email moored@vt.edu

Appendix G: Details of Performance Support Tool Use by Knowledge Producers

Once the knowledge producers were chosen by the owner, he sent an email asking them to consider participating in the study. Once they agreed to participate, I set up a meeting time to explain the study and the type of metadata that is needed. Once the meeting time/place was set, I created a username with the appropriate permissions. The knowledge producers then received an email with the link to the performance support tool, the same as with the owner. When they clicked on the link, it took them to the login page asking them to create a password for the account, this way I would not know the password for any of the users. After the password was set, they could enter the website for the tool. After the training, I asked if I could observe as they started entering metadata and they all agreed that it was fine with them.

The first thing the knowledge producers did was to choose an image from the list of images and then find the corresponding picture (non-digital) based upon the file name that was created when the image was uploaded. They then used the thumbnail to double check that the image and actual picture were the same and the file names matched. They then entered the metadata for the image using the pull-down lists and/or tooltips for help. After saving the item, when they went back to the list, there was a field labeled 'Type' as one of the informational fields, if that was blank then no metadata had been entered for the image but if it had a value then someone had entered metadata. That allowed multiple knowledge producers to be entering data but not have to open each record to see if the metadata had been completed yet (See Figure 32).

Figure 32. List of images.

The knowledge producers had a couple of different options when entering the metadata. One, they could use the ‘Repeat Tag’ button (see Figure 33) to add an additional tag. For example, if the image fell into multiple Projects, then they could use the ‘Repeat tag’ to create additional Project elements (see Figure 33). They could repeat the tag as many times as necessary for any of the elements listed.

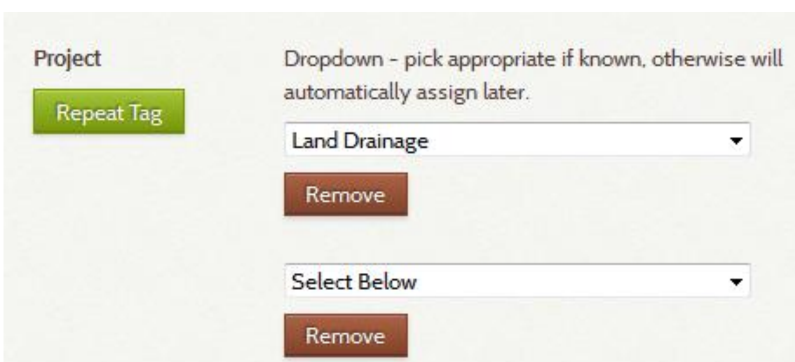

Figure 33. Repeat tag.

Second, if the controlled vocabulary list did not contain the information that they needed, they had the ability to add it to the list. Using the same example above, if the image had a

Project that did not exist in the pull-down controlled vocabulary list, they could go to the ‘Simple Vocab’ tab find the Project in the list of controlled vocabulary terms (see Figure 14 above) and add the additional term. Once they saved the vocabulary list and went back over to the item, it would be in the Project list.

Once they saved a record with the metadata, then they could click on ‘Previous item’ or ‘Next item’ to move to the next record (see Figure 25 above). They would continue to do this for all the images they required metadata entry.

Appendix H: Results from the Pilot Test – Owner

Creation of Metadata Form **Owner:** Early on the save button would scroll off screen as you worked down the page. Some of the terminology gets confusing to me. For example, an item is different than I expected. Also, I was a little confused about the metadata in the beginning versus the metadata items (probably not right term) that I added. Some were duplicates. Finally, it would be good to have the name of image file automatically inserted into that metadata slot.
Revision(s): 1) Fixed the Save button so it did not scroll off the screen. 2) Removed the duplicates to not confuse the knowledge producers. 3) When items are uploaded, the name of the file is automatically inserted into a metadata element.
Controlled Vocabulary **Owner:** I liked this one. It was a little hard to find at first, but once I found it, it was easy and useful. It would be nice to have lookup table capabilities to allow for automatic select of one element in a simple list based on selection in a different list.
Revision(s): 1) I believe this could be resolved by creating multiple collections instead of everything in one collection. Revised this after the pilot test by creating multiple collections, so that when one item is selected it generates the form based on that first selection.
Final thoughts **Owner:** It is nice and I can see trying to use it for my newer research photos. Over last 10 yrs, these are already digital and the best organization I have currently is folders by year, then month. I spend quite a bit of time each week sifting through these. I think an intern could help me metadata these.
Revision(s): None

Appendix I: Results from Pilot Test – Knowledge Producers

Browse items – problems or suggested improvements

Participant 1
***Problems*:** The items menu always reset to page 1
***Improvements*:** Maybe a "show all" button option rather than pages only

Participant 2
***Problems*:** No functional issues.
***Improvements*:** The only suggestion I have, and I don't know if this is even possible, but once you have edited an image and click back to the item list, it takes you to page 1 instead of the page you were previously on.

Revision(s):
1) The Item list displayed 10 items per page, I increased this to 50 items per page to simulate more of a 'show all'
2) No revision was made for the return to page 1

Editing the items – problems or suggested improvements

Participant 1
***Problems*:** None
***Improvements*:** I would recommend only having some of the options come up if you select that option on related questions, just to make the system less overwhelming and seem simpler.

Participant 2
***Problems*:** No functional issues**.**
***Improvements*:** Interface is easy to use. If anything, there were a lot of choices to choose from which made it sort of confusing to decide which tag to asses for each image. I think that is more of a user issue than an interface issue.

Revision(s):
Same revision made based on owner survey about Controlled Vocabularies. Revised this after the pilot test by creating multiple collections, so that when one item is selected it generates the form based on that first selection, this reduces the number of elements that appear as only the elements that are related to the specific selection appear.

Use of tooltips – problems or suggested improvements

Participant 1
***Problems*:** None
***Improvements*:** Tooltips were very helpful, I do not think they need to be improved

Participant 2
***Problems*:** No
***Improvements*:** Tool tips were helpful, but lengthy. Could be shorter for faster reading.

Revision(s):
None, the owner wrote the tool tips, so I do not have control over the length.

Repeat tag to create additional tags – problems or suggested improvements **Participant 1** ***Problems*:** None ***Improvements*:** None **Participant 2** ***Problems*:** A few times, I need to add another tag for photographer but did not realize "Repeat Tag" was an option to do so. ***Improvements*:** N/A
Revision(s): None, not understanding the purpose of the 'Repeat tag' was most likely due to either my instructions were not clear or the participant forgot about this feature.
Was having the image on same page as metadata form helpful? Suggested improvements? **Participant 1:** Yes, but I would try to make the image slightly larger, or easy to click in and out of on the same page(sort of like a pop up) **Participant 2:** Very helpful to have image on current page. It was a good way to second check and make sure you were inputting the correct data for the image.
Revision(s): I revised the image that displays on the screen to make it larger at the top of the form and then continued to display the thumbnail along the side of the form so they could view the thumbnail as they moved down the form when they could no longer view the larger image without scrolling up.
Modifications to existing tool **Participant 1:** None **Participant 2:** I think there are a lot of tags for the final 3 information questions. When I did not know, or thought there could be one or more description for an image, I would leave blank.
Revision(s): I believe having the multiple collections based on the specific location to decrease the number of elements and only having the elements that are relevant to that learning object will resolve this issue.
New Features **Participant 1**: Maybe instead of one large page the questions are asked in related sections (one section location, one section date, one section type, etc.) **Participant 2**: None
Revision(s): Again, I believe having the multiple collections based on the specific location to decrease the number of elements and only having the elements that are relevant to that learning object will resolve this issue.
Final thoughts

<u>Participant 1</u>: I thought the tool was very useful, but simplification of data entry sheets would be my only recommendation **<u>Participant 2</u>**: This was a pretty simple process and easy user interface. I would recommend it other groups who want to incorporate metadata into their projects.
Revision(s): For participant #1, I think having multiple collections simplifies the data entry.

Appendix J: Results from the Field Test

Browse items – problems or suggested improvements

Pilot test participant
Problems: Yes, the item list would not update after I entered the data. But after we talked, it looks like you fixed that.
Improvements: Items menu is good. No changes needed.

Participant 1
Problems: No
Improvements: After you enter data and go back to items menu, the screen is shown from item 1 on the list. It may be useful for it to go back to the last item accessed, wherever that is in the list. Perhaps with a separate way to go to the top of the list again?

Participant 2
Problems: No
Improvements: It would be nice if instead of needing to click the item to view a larger photo you could hover the mouse over it and see a larger image before clicking

Editing the items – problems or suggested improvements

Pilot test participant
Problems: No issues
Improvements: Yes, I like the 1st way with all the options better than the second way.

Participant 1
Problems: No
Improvements: No good ideas come to mind.

Participant 2
Problems: No
Improvements: Move "Description" ahead of "Caption/Title" as most images have a description but not a caption. I am continuously wanting to put the description in the caption box because I sequentially cross it first. It would also be nice to be able to link/combine duplicate photos that had to be recorded more than once because they were in different locations even though they were clearly the same image.

Use of tooltips – problems or suggested improvements

Pilot test participant
Problems: No
Improvements: No, all the options are good

Participant 1
Problems: No
Improvements: The project specific tools were tricky in that I didn't know what to classify things as - I left them blank (the tools that were classifying as erosion control and similar toward the

end of the data input forms). Probably handy for those most familiar with archive materials. Not sure how to improve

Participant 2
Problems: No
Improvements: tool tips were very helpful

Repeat tag to create additional tags – problems or suggested improvements

Pilot test participant
Problems: No functional issues.
Improvements: No.

Participant 1
Problems: No response
Improvements: No – I did use this tool and it worked well

Participant 2
Problems: No
Improvements: No

Was having the image on same page as metadata form helpful? Suggested improvements?

Pilot test participant: Yes, very helpful.

Participant 1: Yes

Participant 2: Yes

Modifications to existing tool

Pilot test participant:

Participant 1: Not sure

Participant 2: It would be nice to be able to link/combine duplicate photos/articles that had to be recorded more than once because they were in different locations even though they were clearly the same image.

New Features

Pilot test participant: Include an "add" button next to the selection tool in order to easily add activities etc. A lot of pictures I would have put them under the category "storm", which could have easily been added with a button option.

Participant 1: Not sure

Participant 2: No response

Final thoughts

Pilot test participant: Overall, this is a very complete and expanse metadata harvester system. Easy user interface that can be used by anyone who understands the data being entered.

Participant 1: Seems easy to use

Participant 2:.No response